4. TAN Support Facility (TSF)

One of the major units of the Test Area North (TAN) complex (see Figure II-2) is the Tan Support Facility (TSF). The TSF encompasses about 70 acres containing about 20 buildings, roads and sidewalks, outside storage areas, railroad trackage, and utilities. The facility, built originally to support the Aircraft Nuclear Propulsion (ANP) program, was activated about 1954. Since cancellation of that program in 1961, the TSF has been utilized for site support and for water reactor safety program activities. Figure II-30 is an aerial photograph of the TSF.

In recent years the TSF has been used primarily for the fabrication and assembly of the LOFT Mobile Test Assembly (MTA). (See Section II.A.5 for a description of LOFT). The anticipated use for the immediate future (3 to 5 years) is also for LOFT activities. TSF also has been used to assemble and house test equipment associated with the water reactor safety program; however, these later test activities have been relocated to EBOR (described in Section II.A.11). Thus, as the name implies, a wide variety of support activities are carried on at the TSF.

Those areas most directly associated with the radioactive waste systems include the hot shops (remotely operated and shielded facilities), underwater storage facilities, cleaning rooms, and laboratories.

Hot Shop Area

The hot shop area provides the capability for remote disassembly, reassembly, and repair of large radioactive components. Large mobile overhead cranes are available to position incoming items. Operations using remotely controlled manipulators then can be performed with handtools and small power tools. When necessary, items may be transferred directly from the hot shop to either a storage pool or to adjoining smaller hot cells.

Radioactive Material Storage Pool

The radioactive material storage pool has a capacity of approximately 500,000 gallons and provides for convenient, economical underwater interim storage of fuel elements and other highly radioactive material. A water circulation system provides capability for cooling and filtering of pool water. Liquid purge is passed through a deionizer to reduce the radioactivity level. The low-level filtered liquid then is discharged into a line for radioactive waste. The line connects to a common sump where four TSF liquid waste streams combine. The mix then is discharged to a disposal pond.

Warm Shop

The warm shop is a general purpose area that may be used either for disassembly and assembly of slightly radioactive components or for general shop work. Except for remote handling, the

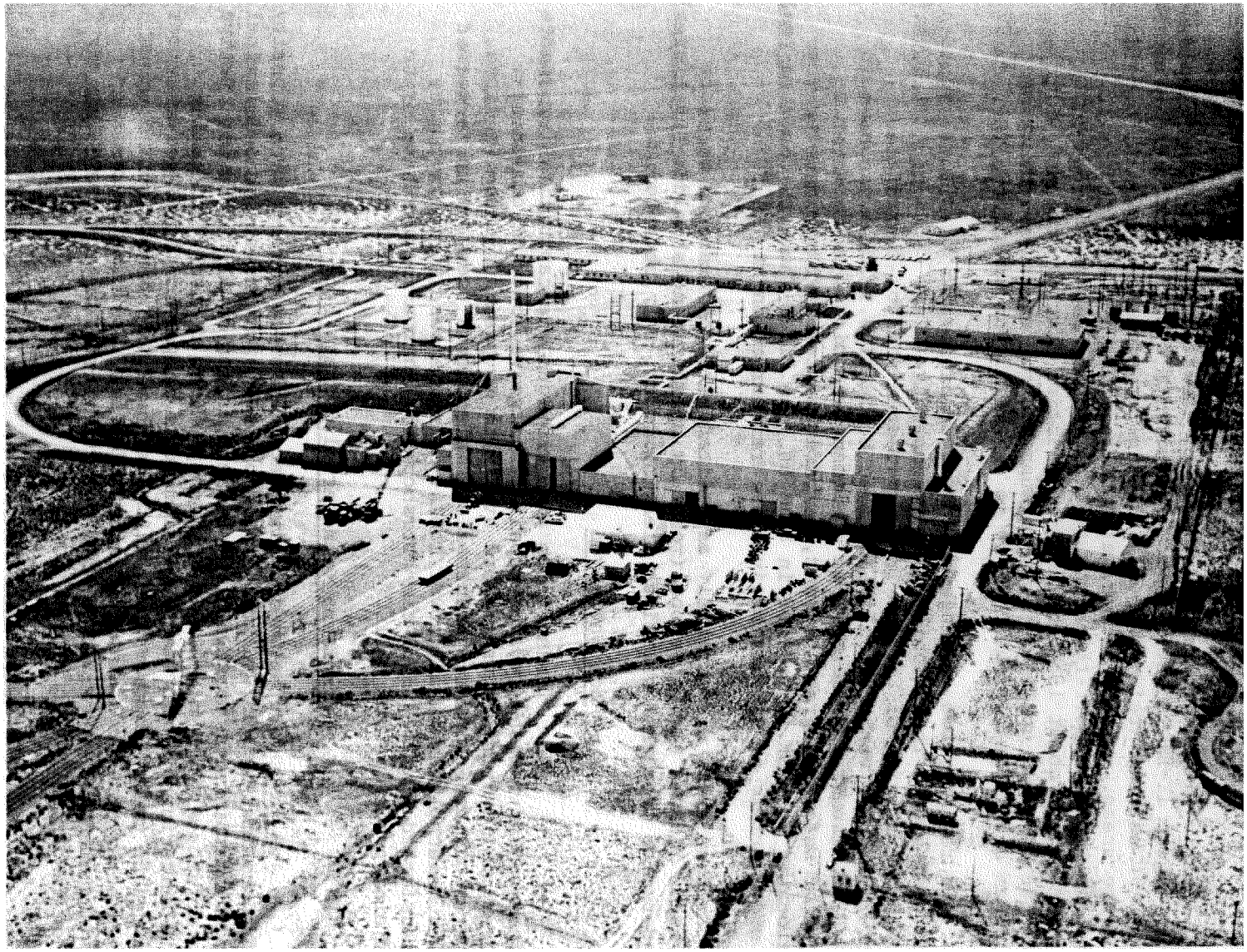

Figure II-30. Aerial View of TSF.

warm shop has many of the capabilities of the hot shop. When working on radioactive components, operations are performed directly by personnel attired in protective clothing.

Cleaning Rooms

Three cleaning rooms are located at TSF. These are the sandblast room, the chemical cleaning room, and the decontamination room. Normally, the generation of radioactive waste is limited to the decontamination room. Although each of the three cleaning rooms is designed for a distinct function, together they provide an integrated cleaning capability.

The decontamination room provides capability for using chemical solutions to remove loose radioactive materials from components and piping. These chemical solutions become radioactively contaminated and may be treated before they are discharged to the radioactive liquid waste system. Accidental discharge of these radioactive liquids to the process waste system (nonradiological liquid), the sanitary system, and the general environs is prevented by design features.

The chemical cleaning room is used normally for the industrial cleaning of nonradioactively contaminated components and piping. The drainage sump piping is designed for the discharge of liquid waste to either the process waste system or the radioactive liquid waste system. It therefore could be used for radioactive decontamination if the need arises.

The sandblast room is used for the removal of tenacious materials (e.g., oxides) from the surface of components and piping. The current design does not provide capability for working on radioactive materials.

Laboratories

The laboratory support area provides local capability for the examination and analysis of small specimens. This capability makes packaging, transferring, and transporting of small items to other INEL facilities unnecessary. Small quantities of radioactive liquid, airborne, and solid wastes can be generated in these areas. Therefore, area design features enhance the safe handling of these materials.

a. Systems for Venting Radioactive Airborne Wastes

Areas within the TSF with the potential for generating radioactive airborne effluent are equipped with systems that continuously remove airborne contaminants from the work areas; the system also filters the particulate components and discharges the remaining effluent to the outside atmosphere.

Eight separate systems have been installed to serve the needs of different areas. Although the flow route for discharge to the atmosphere differs from system to system, the operating principle of all is the

same. Basically, airflow is induced from areas with the least probability of contamination towards the area with the highest probabilities, and the air is exhausted through ducts to the atmosphere. This ensures the inward flow of air from uncontaminated surroundings and induces a flow path that ensures adequate ventilation concurrent with minimizing the escape of radioactive material. Areas with a high potential for contamination (small cells used for handling highly radioactive materials) have HEPA filters in the effluent ducts to remove airborne particulates. Discharge may be either direct to the atmosphere through dampers or out the top of a stack at a height of about 168 ft above grade.

An example of a typical radioactive airborne waste stream at the TSF is that associated with the hot shop area. Outside airflow mixes with air from the warm shop to provide a supply that is divided proportionally and directed to the three hot shop areas to be served. Discharge ducts from each of the three areas and from special equipment (e.g., hooded acid tank) contain a bank of roughing filters, a check valve, and a fan. Individual ducts are joined to a common header that promotes mixing of the streams as flow continues to the effluent stack. Alpha-beta radioactivity level of the effluent is monitored continuously. No provisions have been made for either the removal of radioactive iodine or for the monitoring of gaseous wastes (e.g. xenon, krypton, and argon) because these gases have short radioactive half-lives, and because any fuel material is allowed to age prior to experimental analysis at TSF.

In 1974 the TSF discharged about 0.001 Ci of radioactivity. The majority of this activity was unidentified beta-gamma with trace quantities of cobalt-60, cesium-134, cesium-137, ruthenium-106, strontium-90, and yttrium-90.

The airborne releases that have occured at the TSF since 1958 are listed in Table II-32.

b. Systems for Venting Nonradioactive Airborne Wastes

Nonradiological airborne wastes at the TSF are primarily effluent from boilers. These effluents consist of combustion gases and saturated steam and water from space heating and process systems.

Three oil-fired boilers provide all requirements for space heating, for process hot water and steam, and for hot sanitary water. Airborne effluents released from these boilers to the atmosphere consist of sulfur dioxide, nitrous oxides, carbon dioxide, and particulates. Based upon utilized capacity, the thermal discharge to the atmosphere can range from 6 to 20 million Btu/hr, depending upon the time of year. Sulfur dioxide and particulate discharge to the atmosphere range up to about 3×10^5 lb/yr and 5×10^4 lb/yr, repectively. Waste saturated steam and hot water are released primarily to either the process waste system or to the sanitary system. Final disposal of these liquid effluents is to a waste disposal pond.

TABLE II-32

SUMMARY OF TSF RADIOACTIVE AIRBORNE RELEASE

Year	Radioactivity Released (Ci)
1958	2,000[a]
1959	11,140[a]
1960	20,060[a]
1961	2,524[a]
1962	<1
1963	<1
1964	<1
1965	<1
1966	<1
1967	<1
1968	<1
1969	<1
1970	<1
1971	<1
1972	<1
1973	<1
1974	<1
Total	53,720

[a] The high releases during the 1958-1962 period resulted from the ANP program (see Section II.C.11).

The chemical cleaning room and the sandblast room have separate ventilation systems. Discharge of the airborne wastes from these rooms is directly to the atmosphere through a short stack. The waste stream consists of warm air, water vapor, and dust.

c. System for Disposal of Radioactive Liquid Wastes

The radioactive liquid waste system collects, processes, and has interim storage capacity for all intermediate-level radioactive liquid waste generated at the TSF. The flow stream is shown in Figure II-31. Drains and sumps, located in areas with a high potential for

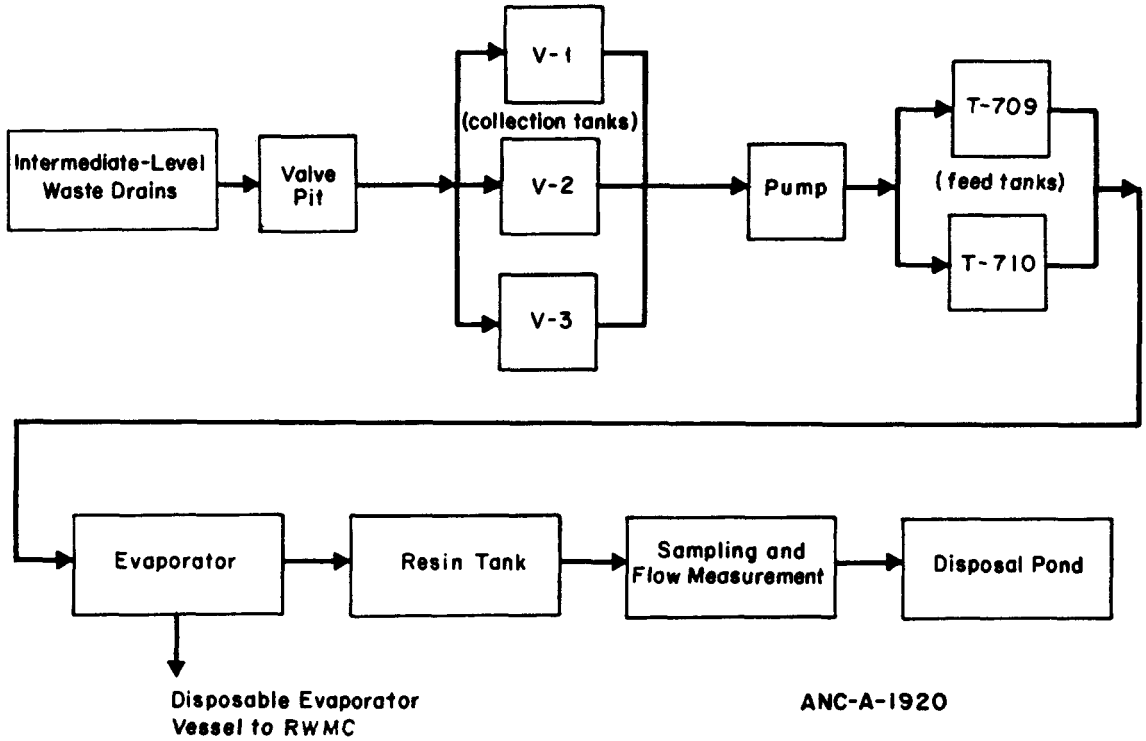

Figure II-31. TSF Radioactive Liquid Waste System Flow Chart.

contamination, are piped to a waste transfer plant. Here the radioactive liquid waste is collected in one of three underground 10,000-gallon-capacity stainless steel collection tanks (V-1, V-2, or V-3). The solution is then pumped into one of two 50,000-gallon underground liquid waste feed tanks (T-709 and T-710).

Originally, liquid waste from the 10,000-gallon collection tanks was concentrated by an evaporator, and the concentrate was transferred to tanks T-709 and T-710 for long-term storage. Later, however, the original evaporator was eliminated and the unconcentrated waste was transferred directly to tanks T-709 and T-710, which served as feed tanks for a subsequent stainless steel evaporator. The liquids and entrained radioactive solids were separated in the evaporator; the solids remained in the evaporator vessel which provides interim storage during processing and also served as the long-term storage container. When filled to capacity (about 20 tons), the semisolid radioactive waste was solidified by evaporation and the container was transferred to the INEL Radioactive Waste Management Complex for disposal. Distillate from the evaporator flowed to the condenser and then to a condensate storage tank. The condensate is passed through a cation ion-exchange column for further removal of radioactive ions. Effluent from the ion exchanger was combined with other TSF low-level radioactive liquid waste prior to discharge into the disposal pond located southwest of the TSF.

During ANP program operations, 92,000 gallons of waste, mostly intermediate-level concentrate, were processed. Two disposable evaporator vessels were used. These vessels, one containing 12 tons and the other 4 tons of dry radioactive solids, were transferred to the INEL Radioactive Waste Management Complex.

The evaporator system at TSF is presently not operable and the total system is undergoing evaluation. During this interim period the collected liquid waste in tanks V-1, V-2, and V-3 is being transferred by tank truck to the ICPP for processing. In June 1975, all of the stored liquid wastes in tanks T-709 and T-710 (approximately 100,000 gallons) were solidified, packaged, and transported to the INEL Radioactive Waste Management Complex for disposal.

Tanks T-709 and T-710 rest in separate concrete cradles. These cradles, filled with coarse aggregate and sand, have sufficient void volume to contain leakage even if the tanks were full. An alarm system has been installed in each cradle. This provides immediate detection that permits transfer of the remaining contents into the other tank held in reserve. Several modifications completed in 1974 have contributed to the overall integrity of the system:

(1) A high-liquid-level visual indicator was installed on collection tanks V-1, V-2, and V-3.

(2) Vacuum pumps were installed as aids for priming the two transfer pumps at the collection station.

(3) An agitator was installed which stirs sludge that has settled in the bottom of tanks T-709 and T-710, and which entrains the sludge in the liquid to be processed.

Low-level radioactive liquids are received in a common sump with several nonradioactive streams prior to discharge to the TSF disposal pond. The combined flow is proportionally sampled at this point prior to discharge.

The disposal pond is an unlined diked area encompassing approximately 35 acres. Rated capacity is about 33 million gallons/yr. Liquid volume is reduced by evaporation and infiltration at an average rate of 880,000 gallon/yr/acre and 79,000 gallon/yr/acre, respectively, after equilibrium conditions are reached. It is estimated that about 30 million gallons/yr will be discharged to the disposal pond. The disposal pond replaced an existing disposal well that was in use until 1972 but is now in standby status. The well will only be used on a temporary basis when, for example, power failure, equipment failure, or equipment maintenance preclude discharge to the disposal pond.

Table II-33 lists the nuclides discharged by TSF in 1974. The discharge volume for this same year was approximately 13 million gallons.

TABLE II-33

TSF LIQUID NUCLIDE SUMMARY FOR 1974

Nuclide	Radioactivity Released (Ci)
Cobalt-60	<1
Cesium-137	<1
Ruthenium-106	<1
Strontium-90	<1
Tritium	2
Unidentified alpha	<1
Unidentified beta and gamma	<1
Total	2

Shown in Table II-34 are the number of curies released to the disposal well and pond since 1959. The higher releases during 1968 and 1969 were caused by problems with an evaporator that was phased out in 1969.

d. Systems for Disposal of Nonradioactive Liquid Wastes

As previously mentioned, nonradioactive streams at the TSF are combined with low-level radioactive streams at a common sump prior to discharge to the disposal pond. Major nonradioactive liquid streams are those processing liquid effluents from the process waste system and the sanitary waste system.

(1) Process Wastes

Some of the liquid waste generated at outside work areas may either seep into the ground in the immediate vicinity or be carried to the disposal pond by drainage ditches. However, most nonradioactive liquid process waste at the TSF is generated in shop areas where floor drains collect waste for discharge to the process waste system.

No vehicle maintenance facilities are located at the TSF; therefore, no liquid petroleum product waste is generated except in the shop areas. Petroleum waste that is not placed in the solid waste stream is collected in containers and transferred to the CFA for disposal or secondary usage as described in Section II.A.8.

(2) Sanitary Wastes

The TSF sewage disposal plant provides primary and secondary treatment of normal household sewage. All influents to building sewers, laterals, and trunklines flow by gravity to a disposal plant.

TABLE II-34

SUMMARY OF TSF LIQUID DISCHARGES

Year	Radioactivity Released (Ci)
1959	11
1960	2
1961	<1
1962	<1
1963	<1
1964	3
1965	<1
1966	<1
1967	<1
1968	10
1969	10
1970	3
1971	5
1972	6
1973	5
1974	2
Total	58

The treatment plant was designed to accommodate a flow of 59,000 gallons/day with an Imhoff retention time of 1.38 hr. The plant consists of an Imhoff tank (3,400 gallons), a chlorinator (560 gallons), a trickling filter (0.067 acre-ft), and a sludge bed (835 ft^3). Settleable solids are separated in the primary clarifier and pumped to a steam-heated anaerobic digester (Imhoff tanks) where they are stabilized. Overflow from the primary clarifier flows by gravity to a trickling filter and then to a secondary clarifier. The overflow from the secondary clarifier is chlorinated and flows to the sump for pumping to the disposal pond. The liquid effluent is sampled weekly for BOD, DO, and pH; a typical analysis is given in Table II-35. Solids on the digester are skimmed periodically, checked for radioactivity, dried, and disposed of as either radioactive or nonradioactive solid waste as applicable.

e. System for Disposal of Radioactive Solid Wastes

The potential exists for generation of solid waste in several of the TSF areas. These waste products may be either radioactive or nonradioactive, and they are segregated at their sources. The radioactive

TABLE II-35

TYPICAL ANALYSIS OF TSF SANITARY WASTE SYSTEM DISCHARGE

Condition	BOD	DO	pH
Raw sewage	47.5	0.867	7.67
Effluent from waste treatment plant	18.6	6.26	7.77

wastes are placed in approved containers that are distinctly identified by color and affixed standard radiation symbols.

Management procedures at the TSF provide control over generated low-level radioactive waste. This control prevents any spread of contaminants outside immediate work areas. Further, the reduced volume of radioactive waste helps decrease costs associated with long-term storage and reduces the volume required for subsurface disposal at the Radioactive Waste Management Complex. The majority of the TSF solid radioactive waste originates from the hot cells. This material is generally low in volume but high in radioactive content. The material is packaged in strong shielded containers and transported to the INEL Radioactive Waste Management Complex. In 1974 the entire TAN complex generated 7000 ft^3 of solid waste totaling 6,719 Ci of activity.

f. System for Disposal of Nonradioactive Solid Wastes

The TSF nonradioactive solid waste is disposed of at either the INEL sanitary landfill located at CFA (described in Section III.A.6) or the TAN solid waste management site. The latter site is a large, remotely located gravel pit about 0.5 mile north of the ANP hangar, about 2 miles from the nearest public road, and about 5 miles inside the nearest INEL boundary. Public access to the site is not permitted, and a locked gate with a 50-ft exclusion fence to either side prevents unauthorized vehicular access to the site.

Disposal at the TAN site is limited to items such as concrete debris, metal scrap, lumber, and other similar solids. Salvageable items are accumulated separately and periodically sold to the public. All other waste is accumulated and covered with earth at least four times each year. All garbage, paper, and material that will blow about are transported to the INEL sanitary landfill for disposal.

In all cases, the waste is collected in specially marked "cold waste" containers and carefully monitored prior to removal from the facility; this procedure prevents the inadvertent spread of radioactive contamination. In 1974 approximately 4,200 yd^3 of nonradioactive solid waste were generated at TSF.

5. Loss-of-Fluid Test (LOFT) Facility

The only reactor operation at the TAN complex is the LOFT facility shown in Figure II-2. An aerial photograph of the area is shown in Figure II-32. About 500 acres have been designated for use by this versatile reactor test facility. Four major parts of the LOFT facility are the Mobile Test Assembly (MTA), low-leakage containment vessel, associated support systems, and equipment-administration building adjacent to the containment.

The MTA is a large railroad dolly with steel framework that supports the components of the reactor and primary coolant system. Further, the railroad dolly provides mobility, using a shielded locomotive, for transferring the test system from the containment vessel to the TSF area when any major maintenance is required. The components of the LOFT reactor and primary coolant system of the MTA are the reactor vessel with shield tank, pressurizer, primary coolant pumps, steam generator, and primary coolant pipes that connect these components. This dolly mounted reactor system has the capability for simulating a spectrum of primary coolant pipe-rupture experiments that test the performance of engineered safety features. The LOFT reactor is capable of operating at 55 MW of thermal power. During normal operation, heat generated in the reactor core is removed continuously by the circulating primary system coolant (water). This coolant passes through the steam generator where heat is transferred to the coolant water of the secondary system. Heat transferred to the secondary system finally is rejected to the outside atmosphere via air coolers.

During normal operation and routine experiments, the MTA is located in a low-leakage containment vessel. This is a cylindrical welded-steel shell 70 ft in diameter and 129 ft high. The MTA enters and exits the containment vessel through a large railroad entry door; this access opening is the major deviation from the design of conventional containment vessels. The railroad door, designed to be part of the containment pressure boundary and leakage barrier, is equipped with double inflatable pneumatic seals.

Support systems of the LOFT facility include those appropriate for any major test facility and also those necessary for performing special tasks. The LOFT systems include compressed air supplies; water supplies; electrical power distribution; heating and ventilating (HV); and treatment for airborne, liquid, and sanitary wastes.

Adjacent to the containment vessel is the control and equipment building, which provides shielded space for reactor control equipment, experiment instrumentation, and office space.

Waste Systems

Waste support systems are not yet operational, as the LOFT facility is in the final stages of construction. The quantities of waste to be generated at the LOFT facility have been estimated and reported in an environmental statement[40].

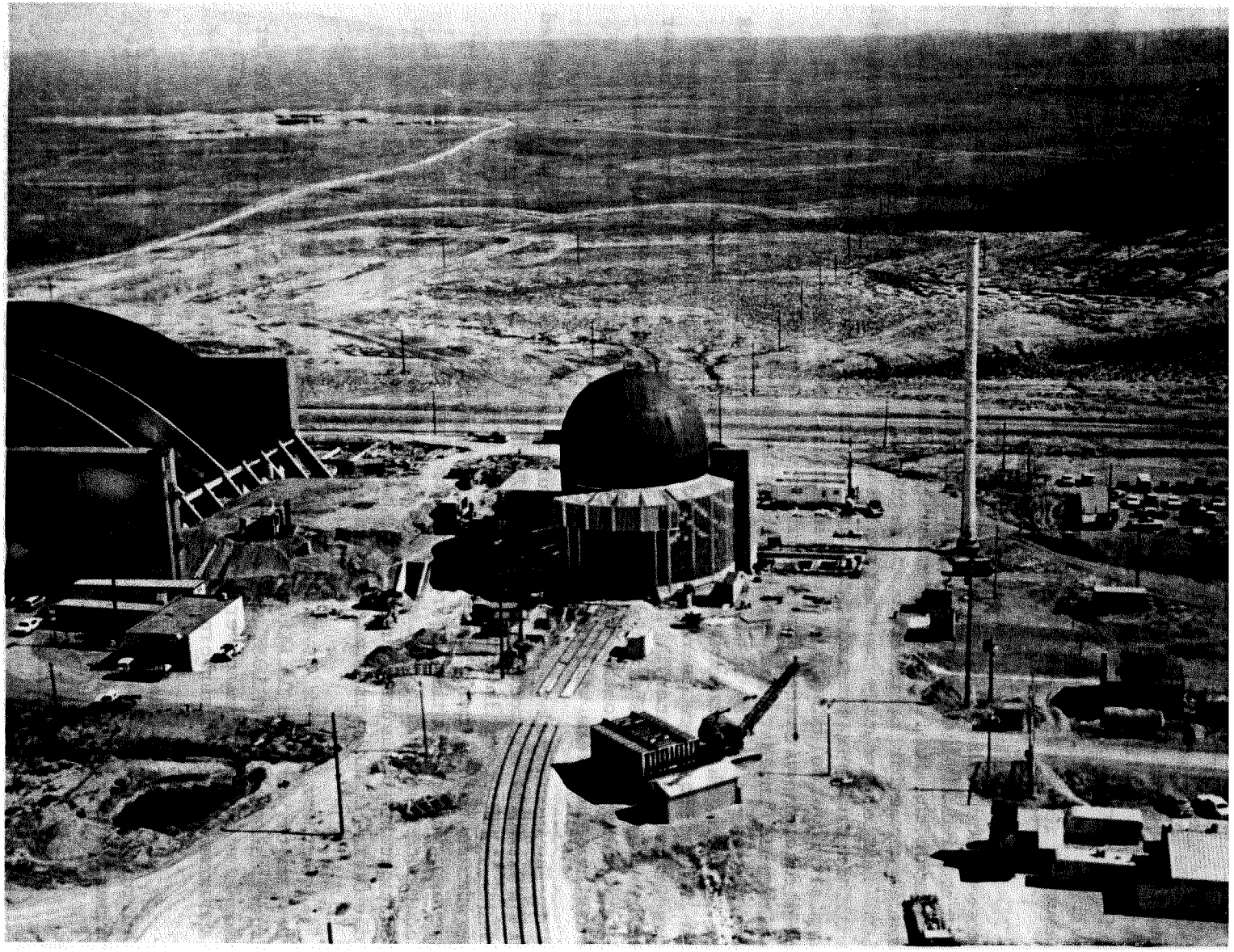

Figure II-32. Aerial View of LOFT.

This facility has several specifically designed systems installed to control and minimize the release of undesirable materials to the environment. These special systems include:

(a) A collection system (called a "blowdown suppression system") for containing the total inventory of material exhausted from the reactor primary coolant system during the conduct of most experiments

(b) A filter system to clean up the containment vessel atmosphere for those experiments exhausting to the containment vessel

(c) An intermediate radioactive waste interim storage system for contaminated liquids

(d) A radioactive waste gas filter system for filtration of contaminated air from waste tank vents and other plant sources

(e) A pressure reduction spray system, which can wash radioactive contaminants from the containment vessel atmosphere and reduce containment vessel pressure following blowdown to the containment vessel

(f) A low-leakage containment building.

The blowdown suppression system deserves special mention. This system is used to contain the blowdown effluent from experiments and, hence, is a major factor in reducing environmental releases from the LOFT experiments. The tank and header assembly of approximately 3,000 ft^3 is partially filled with borated water. Steam and water ejected from a simulated break in the primary coolant piping are piped to the blowdown suppression tank, where the steam will condense to water. Most radioactive materials dissolved in the condensate are removed by ion-exchange beds in a water cleanup system. Radioactive gases trapped in the blowdown suppression tank are retained, sampled, and released through a gas filter single-pass system prior to being exhausted to the atmosphere via a 150-ft stack. Discharge is allowed only under preselected monitored meteorological conditions.

The waste streams and releases to the environment, both radioactive and nonradioactive, are discussed in the following subsections.

a. Systems for Venting Radioactive Airborne Wastes

(1) Sources of Radioactive Airborne Wastes

Releases to the atmosphere from the LOFT facility include radioactive gases and particulates generated during routine reactor operation and during experiments. During routine operation it is possible that some fuel pin leakage could occur, which would allow fission products to enter the primary cooling water. The primary coolant would then include noble gases (isotopes of krypton and xenon) and some other volatile

species. There are then several ways in which these gases could be released to the atmosphere. The following are examples of escape routes:

(a) Vents from tanks which receive primary coolant

(b) Valve stem leakage from valves in the primary system

(c) Leakage from the primary to secondary side of the steam generator and then to a number of secondary vents, secondary leaks, etc.

(d) Blowdown to the suppression tank and, after appropriate holdup, release to the atmosphere via a filter system and stack

(e) Blowdown to the containment vessel then leakage at a very slow rate to the atmosphere

(f) Off-gas from the waste system pumps, storage tanks, and sampling areas.

To preclude or to control the release of radioactive gases and particulates, numerous HV systems and subsystems have been installed. The two major systems are the containment vessel HV system and the LOFT HV system.

(2) Containment Vessel HV System

The containment vessel HV system is provided to supply air to heat, ventilate, cool, humidify, and clean up the containment vessel test chamber and basement. All experiments will blow down to a blowdown suppression tank, and no release of fission products to the containment atmosphere is expected. Off-gas from the blowdown suppression tank is routed through a moisture separator, particulate filters, and charcoal adsorbers to remove airborne particulates and radioactive iodines before the air is released through a 150-ft-high stack.

During normal operation the containment vessel HV system receives its makeup air from an outside air intake. Two routes exist for exhausting this air to the atmosphere. Usually air is exhausted from the containment vessel directly to the exhaust stack. During filter operations, however, air is recirculated continuously from the containment vessel through the filter system until the level of contamination is within applicable standards[7] and then is discharged to the exhaust stacks. A separate exhaust duct connects the containment vessel to the main filter vault; this precludes the contamination of ventilating ductwork through which air flows during normal operations.

The filter and adsorber media used in the system include a moisture separator to remove the entrained moisture, roughing and HEPA filters to remove the particulate materials, and impregnated charcoal adsorbers to remove the halogens. The air is heated after leaving the moisture

separator to prevent plugging or weakening of the particulate filters by condensation of moisture from the airstream. The filter and adsorber media housing facilitates easy removal of any individual filter without disturbing the adjacent filter.

(3) LOFT HV Systems

The HV system for the control and equipment building operations and for the service building provides heating, ventilation, cooling where required, fresh air change, and radioactive contamination control. The system minimizes the spread of radioactive contamination by employing independent subsystems to provide space pressurization as required. Areas with minimal potential for becoming radioactively contaminated are maintained at a slightly higher pressure than areas likely to become contaminated.

The air flowing through the HV subsystem serving potentially contaminated areas is filtered by a set of roughing filters, HEPA filters, and a charcoal adsorber before being exhausted to the stack. Two parallel filter banks are provided; one of the banks is used as a backup. A backup fan also is provided to ensure the continuous operation of this system during all modes of facility operation.

(4) Stack Radiation Monitoring System

The stack radiation monitoring system consists of a stack gas effluent measurement loop containing an air particulate monitor, a gas monitor, and a stack gas flow measuring system.

Each measurement system consists of a detector, indicator/amplifier, and strip chart recorder. Audible and visual alarms are activated whenever the radioactivity level exceeds predetermined trip points.

A gas monitor is installed downstream from the particulate monitor to measure the radioactive gaseous effluent. The gaseous material to be measured includes: naturally occurring radioactive gases (radon, etc.), gaseous fission products (xenon and krypton), and activated atmospheric gases (argon-41, etc.).

Table II-36 lists conservative estimates of atmospheric releases of radioactivity which could result from all operations, except a hypothetical accidental blowdown within the containment vessel. These values are upper-limit estimates and actual releases will be much lower as the radionuclides are controlled within the blowdown suppression tank and allowed to decay before discharge, through filters, to the atmosphere.

b. Systems for Venting Nonradioactive Airborne Wastes

Nonradioactive airborne effluents will result from the operation of two small oil-fired service steam and space heating units. Each of the two boilers is rated at 10 million Btu of heat input. The anticipated sulphur dioxide and particulate release rates are given in Table II-37.

TABLE II-36

CONSERVATIVELY ESTIMATED AIRBORNE RADIOACTIVITY RELEASES FROM LOFT EXPERIMENTS

Isotope(s)	Radioactive Half-Life	Estimated Activity Release (Ci/yr)	
		Leakage from Containment	Controlled Release from Vessel Cleanup System
Xenon-133	5.3 days	130	360,000
Xenon-135	9.2 hr	138	110,000
Krypton-85	10.8 yr	0.076	220
Total noble gases		1,350	470,000
Strontium-90	28 yr	0.0058	0.0005
Cesium-137	30 yr	0.0058	0.0005
Iodine-131	8.1 days	6.4	0.1
Other iodine Isotopes	21 hr (Maximum)	63	0.35
Tritium	12.3 yr	0.00025	5

TABLE II-37

NONRADIOACTIVE AIRBORNE WASTES

Source	Expected Release Concentration (lb/MBtu[a])	Expected Annual Release (lb)	Concentration at Site Boundary ($\mu g/m^3$)	Annual Guidelines at Site Boundary (Primary and Secondary) ($\mu g/m^3$)
Oil-fired boiler for producing service steam:				
Particulate	0.1	11,800	5 $\mu g/m^3$	75 and 60
Sulfur dioxide	2.8	331,000	$\sim$0.03 $\mu g/m^3$	80 and 60

[a] MBtu = 1 million Btu.

This shows that the releases are less than the acceptable level for boilers this size specified in the State of Idaho regulations[41], and the new national primary and secondary standards set by the EPA[42]. No situations are envisioned in which the boiler exhausts would produce ambient air concentrations of sulfur dioxide or particulates which exceed the 24-hr standards. Exhausts from the intermittent operation of gasoline or diesel powered equipment do not produce air concentrations in excess of 1% of the applicable standards.

c. Systems for Disposal of Radioactive Liquid Wastes

The LOFT liquid waste systems (Figure II-33) are designed to assure control of the contaminants (radioactive and nonradioactive) and to minimize any potential environmental impact. The four categories of liquid waste discharges are interim storage, surface disposal ponds, disposal well, and infiltration field.

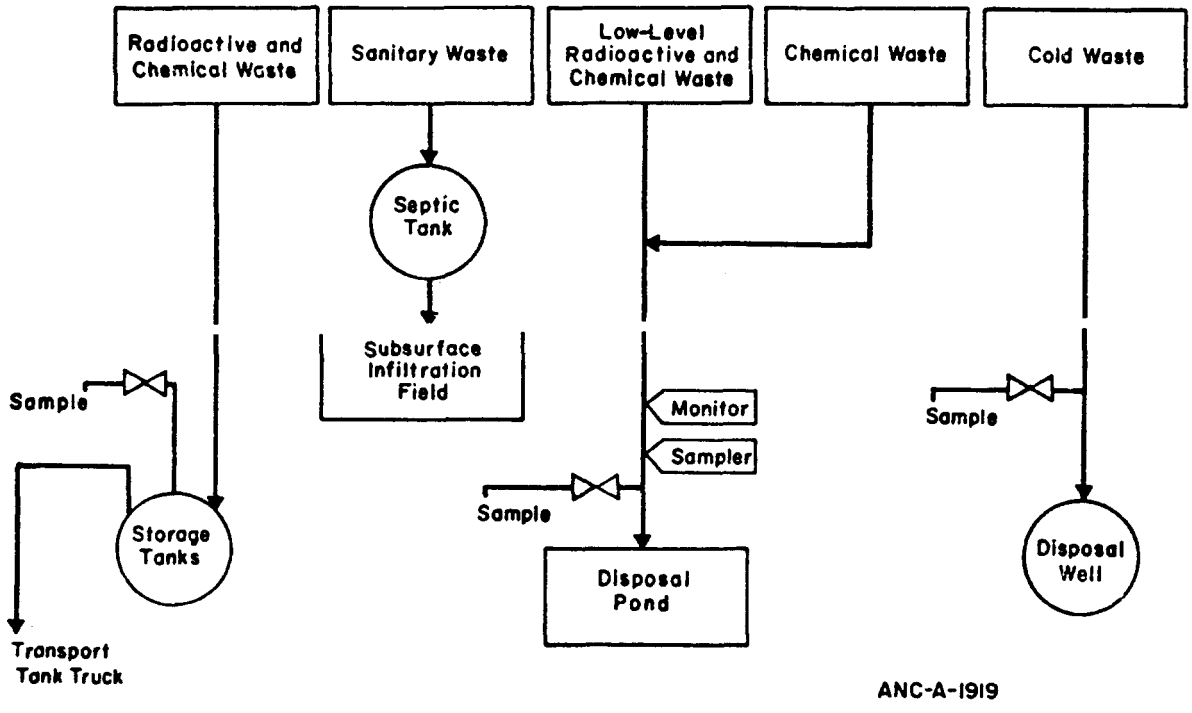

Figure II-33. Schematic of the LOFT Liquid Waste Systems.

(1) Intermediate-Level Radioactive and Chemical Wastes

The intermediate-level radioactive waste system handles the wastes that are anticipated to contain radioactive nuclides or chemicals that will exceed the limits for waste disposal to surface ponds. The major sources of this waste are from the blowdown, emergency core cooling, pressure reduction spray, and decontamination systems. These wastes are collected in one of two shielded 50,000-gallon capacity underground tanks. Between tests the waste is transported to the ICPP for eventual calcination and storage. Much of this waste also contains boron and other chemicals.

Although the two underground LOFT tanks are for interim storage only, they have designed safety features to preclude any inadvertent release to the environment. The tanks are enclosed in a shielded concrete vault of sufficient capacity to contain the contents of the tanks should a leak occur. In addition, a leaking tank can be detected from the level instruments located in each of the tanks and in the vault sump.

(2) Low-Level Radioactive and Chemical Wastes

Liquids that are normally free from radioactivity -- and those which may contain small amounts of radioactivity from flushing operations, heat exchanger leaks, or personnel decontamination -- are monitored and sampled prior to release to a fenced surface disposal pond which is located in a pit near the LOFT facility. These liquid wastes are produced during routine reactor operation. The estimated rate of radioactive discharge to the disposal pond is 150 Ci/yr. Within one month this activity is reduced to about 1.5 Ci, as much of this activity is due to isotopes with half-lives ranging from fractions of a second to less than 30 days. Table II-38 shows the expected concentrations of nuclides, with half-lives greater than 30 days, in the surface disposal pond resulting from routine reactor power operation. The expected annual discharge volume associated with the 150-Ci radioactivity discharge is 24 to 73 million gallons.

The expected LOFT test program will result in the deposition of, at most, 0.00006 Ci of strontium-90 and 0.040 Ci of cesium-137 in the first few feet of soil beneath the disposal pond. After testing is completed, the pond residue will be covered with soil to provide an overburden of at least 6 ft.

Figure II-34 is a generalized geologic diagram of the LOFT disposal pond showing the layers of basalt and sedimentary material which lie below the bottom of the pond. The time required for the liquids to move through this material to the aquifer is approximately four to six weeks. The movement of the water in the aquifer at LOFT is expected to be about 10 ft/day in a generally southerly direction. In addition to the removal of fission products by ion exchange in the sedimentary layers above the aquifer, the radioactive decay in transit will further reduce the tabled concentrations before the waste water reaches the aquifer.

TABLE II-38

RADIONUCLIDE DISCHARGE CONCENTRATIONS AND RATES[a] [43]

Radionuclide	Radioactive Half-life	Discharge Concentrations (μCi/ml)[b] 200 EFPH	2000 EFPH	Concentration Guides for Drinking Water (μCi/ml)[c]	Discharge Rate (Ci/year)[d]
Strontium-89	50.8 days	2.5×10^{-10}	1.3×10^{-8}	3×10^{-6}	7.5×10^{-4}
Yttrium-91	58.8 days	2.5×10^{-10}	1.5×10^{-8}	3×10^{-5}	8.6×10^{-4}
Cerium-144	284 days	6.0×10^{-12}	5.0×10^{-9}	1×10^{-5}	2.9×10^{-4}
Strontium/yttrium-90	28.9 years	3.2×10^{-12}	2.6×10^{-10}	3×10^{-7}	1.5×10^{-5}
Zirconium-95	65.5 days	2.5×10^{-10}	1.5×10^{-8}	6×10^{-5}	8.5×10^{-4}
Cerium-141	32.5 days	4.9×10^{-10}	2.2×10^{-8}	9×10^{-5}	1.3×10^{-3}
Ruthenium-103	39.8 days	2.0×10^{-10}	9.7×10^{-9}	8×10^{-5}	5.5×10^{-4}
Niobium-95	35.1 days	2.0×10^{-11}	8.5×10^{-9}	1×10^{-4}	4.8×10^{-4}
Tellurium-129m	34.1 days	2.4×10^{-9}	1.2×10^{-7}	3×10^{-5}	6.6×10^{-3}
Ruthenium-106	368 days	2.9×10^{-12}	2.3×10^{-10}	1×10^{-5}	1.3×10^{-5}
Cesium-137	30.2 years	2.1×10^{-9}	1.7×10^{-7}	2×10^{-5}	9.8×10^{-3}
Tritium[e]	12.3 years	5.0×10^{-6}	5.0×10^{-5}	3×10^{-3}	3.9
Activation products[f]	Varies	1.5×10^{-8}	1.5×10^{-8}	[f]	1.1×10^{-3}

[a] Discharges to disposal pond resulting from small system leaks during reactor power operation. Only nuclides with half-lives greater than 30 days and which are major contributors to the total are shown.
[b] Concentrations in waste discharge line, assuming a fission product inventory from 200- and 2,000-hr operation at 55 MW.
[c] ANS Manual Chapter 0524, Table II, column 2 (or 10 CFR Part 20) concentration guides for drinking water based on TRC guidelines.
[d] Yearly discharge rates assume three 200-hr and one 2,000-hr power runs per year.
[e] Nearly all tritium discharged is produced in the primary coolant, so concentration and discharge rates are independent of the percent of fuel pin leakage.
[f] The four principal neutron activation products produced are cobalt-58, cobalt-60, manganese-54, and iron-59 The radioactive half-lives vary from 45 days for iron-59 to 5.2 years for cobalt-60. Discharge concentration and discharge rate are independent of the percent of leaking fuel pins. Concentration guides vary from 3×10^{-5} μCi/ml for cobalt-60 to 1×10^{-4} μCi/ml for manganese-54. The tabled concentration is the sum for all four activation product concentrations.

d. Systems for Disposal of Nonradioactive Liquid Wastes

The estimated maximum yearly quantities and average concentrations of nonradioactive chemical contaminants in water to be discharged to the fenced disposal pond are shown in Table II-39. The total annual volume of water to be discharged is estimated to be a maximum of 73 million gallons/yr. These discharge rates and concentrations are slightly less than the values in the table. The concentrations for a projected volume of 24 million gallons are not significantly different from the tabled values, and the discharge rates are one-third of the tabled values. Table II-40 shows the expected ionic concentrations for the discharge water, together with various limits which have been established by the EPA and the State of Idaho.

As shown in Figure II-33, nonradioactive liquid waste from the LOFT facility will be discharged to a disposal well. These wastes consist primarily of service water used for cooling of heat exchangers.

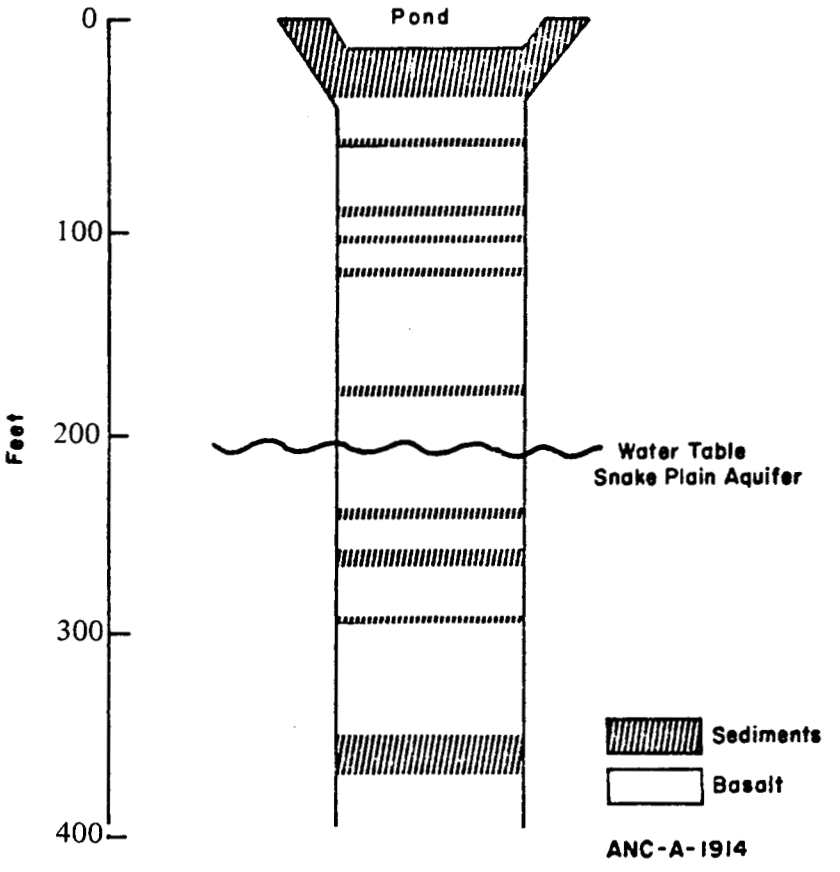

Figure II-34. Generalized Geologic Diagram of the LOFT Disposal Pond.

TABLE II-39

ESTIMATED MAXIMUM CHEMICAL DISCHARGE RATES TO AND CONCENTRATIONS IN DISPOSAL POND

Chemical	Discharge Rate (lb/yr)	Discharge Concentration (mg/l)
Chlorine	130	0.2
Sodium chloride	13,000	26
Sodium hydroxide	1,500	3.0
Sodium sulfite	7.5	0.014
Sulfuric acid	1,500	3.0
Tri-bisodium phosphate	710	1.4
Boron	2,700	15

TABLE II-40

ESTIMATED MAXIMUM ION CONCENTRATIONS FOR LOFT DISCHARGE WATER AND ION CONCENTRATION GUIDE VALUES

Ionic Species	Loft Discharge Concentration (ppm)	Permissible Concentration (ppm)	Desirable Concentration (ppm)
Chloride	16	250[a]	25[a]
Sulfate	3.0	250[a]	50[a]
Phosphate	1.0	50[b]	-
Sodium	12	115[b]	10[b]
Boron	15	1[a]	-

[a] Water Quality Criteria, Federal Water Pollution Control Administration (now the Water Quality Office of EPA).

[b] Water Quality Criteria, State of California (adopted on an interim basis by the State of Idaho).

e. Systems for Disposal of Sanitary Waste

The sanitary domestic wastes resulting from occupancy and operation of the LOFT facility will be disposed of using a combination septic tank chlorinator and infiltration field arrangement which can process up to 1,500 gallons/day. The infiltration field will have 11 drainage lines with a dosage chamber and distribution box to ensure utilization of the entire area of more than 6,000 ft^2. The system, designed in accordance with standards of the U. S. Public Health Service, can accommodate up to 60 persons occupying the facility (assuming an 8-hr waste volume of 25 gallons/person).

f. Systems for Disposal of Solid Wastes

Some of the solid wastes resulting from the LOFT experiments will be radioactive. The solid wastes will be produced primarily during refurbishing of the containment vessel and during refueling of the reactor system. Typical solid wastes will be contaminated equipment that requires replacement, spent ion-exchange resins, rags, and other industrial type materials. These solid wastes will be packaged and shipped from the LOFT site to the INEL Radioactive Waste Management Complex. The estimated volumes and radioactivity contents of these wastes are given in Table II-41.

Nonradioactive solid waste generated at the LOFT facility will be collected, segregated, processed, and disposed of at the CFA sanitary landfill.

TABLE II-41

RADIOACTIVE SOLID WASTE ESTIMATES

Source	Estimated Volume (ft^3/yr)	Composition	Estimated Total Activity (Ci/yr)[a]
Purification and cleanup of system resins	18	Spent resins	10 to 20,000
Purification system filters	2	Filters	1 to 100
Decontamination wastes	1,425	Blotting paper, rags, etc.	1 to 1,000
Waste gas particulate filters	40	Filters	1 to 1,000
Waste gas chemical absorbers[b]	104	Charcoal absorbers	10 to 5,000

[a] Only a small fraction of the total activity will be long-lived isotopes such as strontium-90 and cesium-137. The vast majority of the activity will consist of nuclides with half-lives less than 1 year

[b] Although the filters may collect up to 55 Ci of iodine per year, they do not require changing (the radioactive half-lives of most iodine radioisotopes are relatively short).

g. System for Disposal of Thermal Waste

During LOFT reactor operations, waste heat from several systems will be transferred to the water discharged to the uncontaminated waste disposal well and to the surface disposal pond (Figure II-33). Raw water having an average temperature of 52°F when taken from the production well passes through a once-through heat exchanger, then is discharged down the disposal well at an average temperature of 78°F. During reactor power operation periods, an average of about 38,000 gallons/day of cooling water will be required. No adverse effects on groundwater quality are expected from these discharges.

The average temperature of water discharged to the pond is to be approximately 88°F. The heat will be lost through evaporation and by transfer to the sediments and basalt as the water percolates downward.

6. Power Burst Facility (PBF)

The PBF is a high-performance, water-cooled, uranium oxide fueled reactor which, together with its auxiliary and test equipment, is designed to provide information in support of the ERDA's light-water reactor safety program. The reactor has been designed to operate at powers up to 40 MW for time intervals up to 48 hr. Figure II-35 is an aerial photograph of the PBF area.

The facility is housed in two buildings: a reactor building and a remote control building. The reactor building houses the reactor and its auxiliary systems including those providing raw water, electrical power, plant and instrument air, and heating and ventilating air. This building is a three-level structure with two levels below ground. The reactor facility is constructed of concrete and is located below grade to provide additional radiation shielding during operation. An evaporative cooling tower near the reactor building removes experiment and reactor heat. Operating personnel are housed in the control building located at the PBF control center which utilizes some of the existing facilities that served the SPERT area (described in Section II.A.12). The control building also houses the instrumentation and reactor control equipment. An environmental statement[44] has been written on the facility. A resume of the material found in that statement follows.

a. Systems for Venting Radioactive Airborne Wastes[a]

The principal sources of radioactivity in the PBF airborne effluent are the noble gases and iodines that may be available for release from a closed test loop that penetrates into the reactor. The loop system collects these gases and provides holdup time, allowing short-lived radionuclides to decay.

Noble gases generated during operation of the closed experimental loop are trapped either in the loop pressurizer or the knockout drum and are available to be bottled for storage or processing. To protect personnel from an inadvertent escape of noble gases, the bottle manifold is enclosed with a negative pressure maintained on the enclosure to draw any escaped gases into the waste gas handling system. The storage bottles are cylinders shielded with 1 in. of lead to protect personnel from external radiation.

The design of the PBF airborne waste gas handling system ensures that the gasflow is from the least to highest potential areas of air activity. Four monitoring devices are used with the airborne waste system as protective devices: three constant air monitors (CAMs), and one analytical stack gas monitor. The particulate and gaseous activity being discharged through the stack is recorded continuously. Audio and visual alarms are activated at the instrument, reactor building, and control building in the event of malfunction or high radiation.

The airborne waste gas handling system contains and collects vent gases from various sumps, liquid waste holding tanks, and coolant systems.

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[a] See Appendix B, Section 4.D. for system improvements projected for 1977.

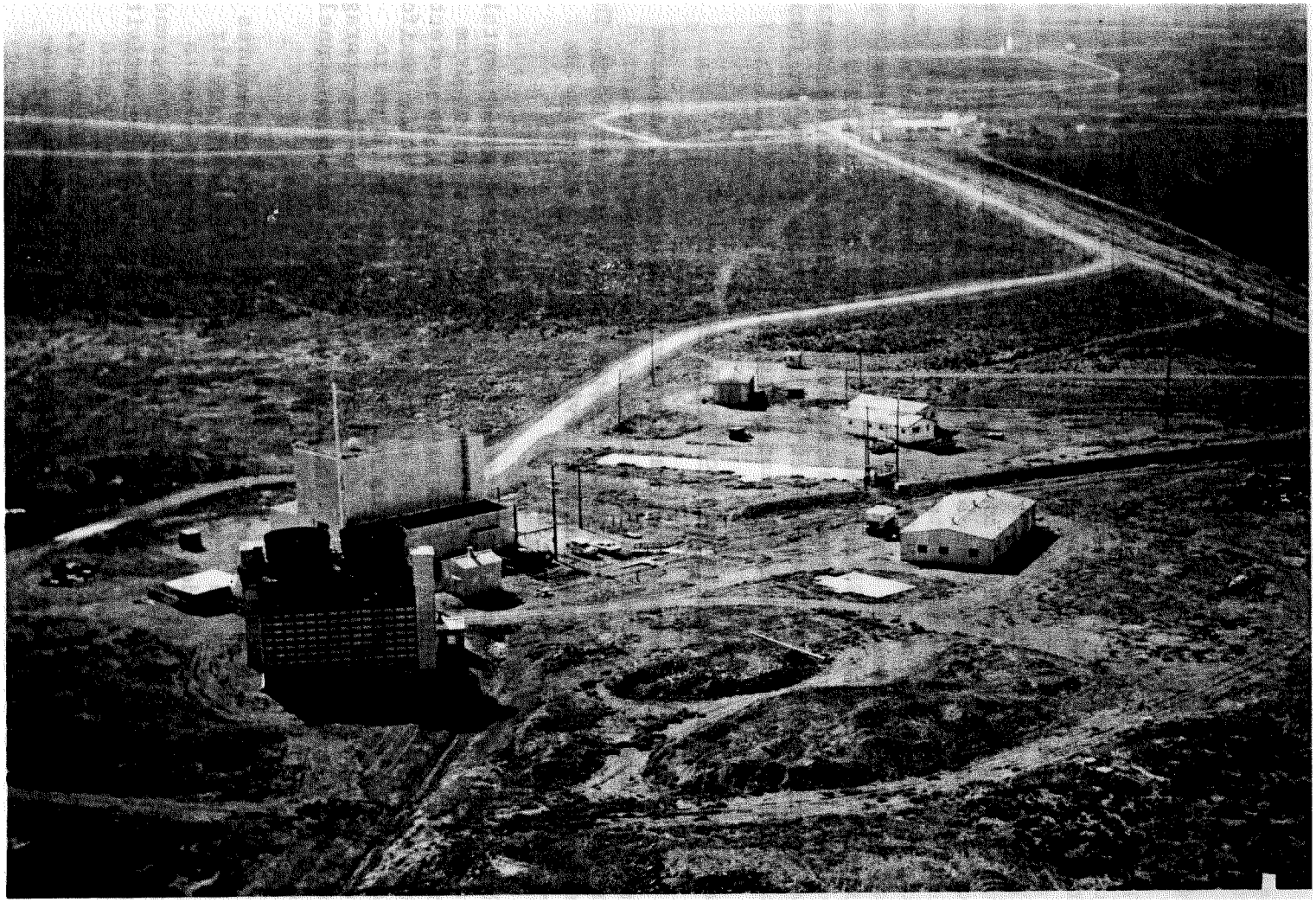

Figure II-35. Aerial View of the PBF.

All airborne wastes flow into an exhaust room plenum and are discharged to the atmosphere through a stack. All exhaust air drawn into the main exhaust room plenum passes through the throwaway filters (which prevent large particulate matter from reaching the absolute filters), through the iodine adsorption beds into the exhaust fan plenum, and then to the 80-ft-high stack.

The iodines and particulates contained in the building air are removed in the waste treatment portion of the waste gas handling system. Particulate matter is removed from the building exhaust air by roughing filters followed by a bank of six HEPA filters. Removal of 99% of any iodine contamination in the building air is accomplished by passing the waste gas over iodine adsorption beds which are physically located above but downstream from existing HEPA filters in a waste gas room. Silver zeolite is used as the iodine adsorption medium because of its resistance to fire, ability to be effective in an environment of high humidity and high radiation, ability to adsorb organic iodines, and capability of remaining effective until exhausted by the adsorption of iodine.

The calculated maximum quantities of fission gases projected to be released from the PBF annually are shown in Table II-42. The argon-41 values result from the activation of stable argon as cooling air flows through reactor control rod guide tubes. The values in Table II-42 are conservative, and when the plant operates at design levels, the airborne effluent stream will be continually monitored to establish actual release values.

b. Systems for Venting Nonradioactive Airborne Wastes

The nonradioactive airborne wastes from PBF originate from operation of small oil-fired boilers used for space heaters, from fossil fuel-driven generator sets for electrical power, and from evaporation of water from the cooling tower.

The combined boilers are rated at 2.2 million Btu of heat input. No. 2 oil is used for fuel. The rate of release of particulates is expected to be 0.28 lb/hr which is less than the currently acceptable emission rate of 1.3 lb/hr by boilers of this size specified in the State of Idaho regulations. Sulfur dioxide concentrations in the boiler stack are estimated to be 530 ppm. Exhausts from the boiler stacks and the generators are checked routinely to assure that the effluents are maintained within the applicable air pollution standards.

The effects of water vapor released from the cooling tower during intermittent operation of the PBF at 40 MW will not be significant. Experience with similar towers has shown that the visible plume dissipates within a few hundred feet of the tower, even under unfavorable conditions. The waste heat will be dissipated to the atmosphere by the cooling tower.

TABLE II-42

POSTULATED ANNUAL RELEASES OF RADIOACTIVE GASES[a]

Gas	Maximum No. of Curies Released In 1 Year[b]	Radionuclide Half-Life
Krypton-85	100	10.8 yr
Krypton-87	9.500	76 min
Krypton-88	13,000	2.8 hr
Xenon-133	5,500	5.3 days
Xenon-135	20,000	9.2 hr
Argon-41	290	1.8 hr
Tritium	2.6	12.3 yr
Total noble gases and tritium	48,000 (Approximately)	
Iodine-131	0.045	8.1 days
Iodine-132	0.13	2.3 hr
Iodine-133	0.38	21 hr
Total iodine	0.56	

[a] Assumes 5% of the noble gases and 0.0001% of the iodines released to the atmosphere from 200 preirradiated fuel rods averaged over 1 year (20 tests with preirradiated rods per year and 10 rods fail per test).

[b] No credit has been taken for radioactive decay during holdup in the experimental loop.

c. Systems for Disposal of Radioactive Liquid Wastes[a]

Low-level radioactive liquid waste and corrosive waste can be pumped directly to shallow disposal wells (Figure II-36). Intermediate-level radioactive liquid waste is either held in a tank (for decay) until it can be pumped to the disposal well, or pumped to a truck for transport to the ICPP.

The PBF liquid waste system is designed to ensure control of the contaminants and to minimize any potential environmental impact. Most equipment drains, canal and reactor drains, etc., flow into a 1,500-gallon waste sump. When the liquid in the sump reaches a predetermined level, a level switch activates a pump and the liquid is pumped from the sump to a disposal well. A proportionate sample of the stream is collected during transfer of liquids from the sump to the well. In addition, a radiation monitor is placed on the exit piping of the waste

[a] See Appendix E, Section 4.D. for planned system improvements in 1979.

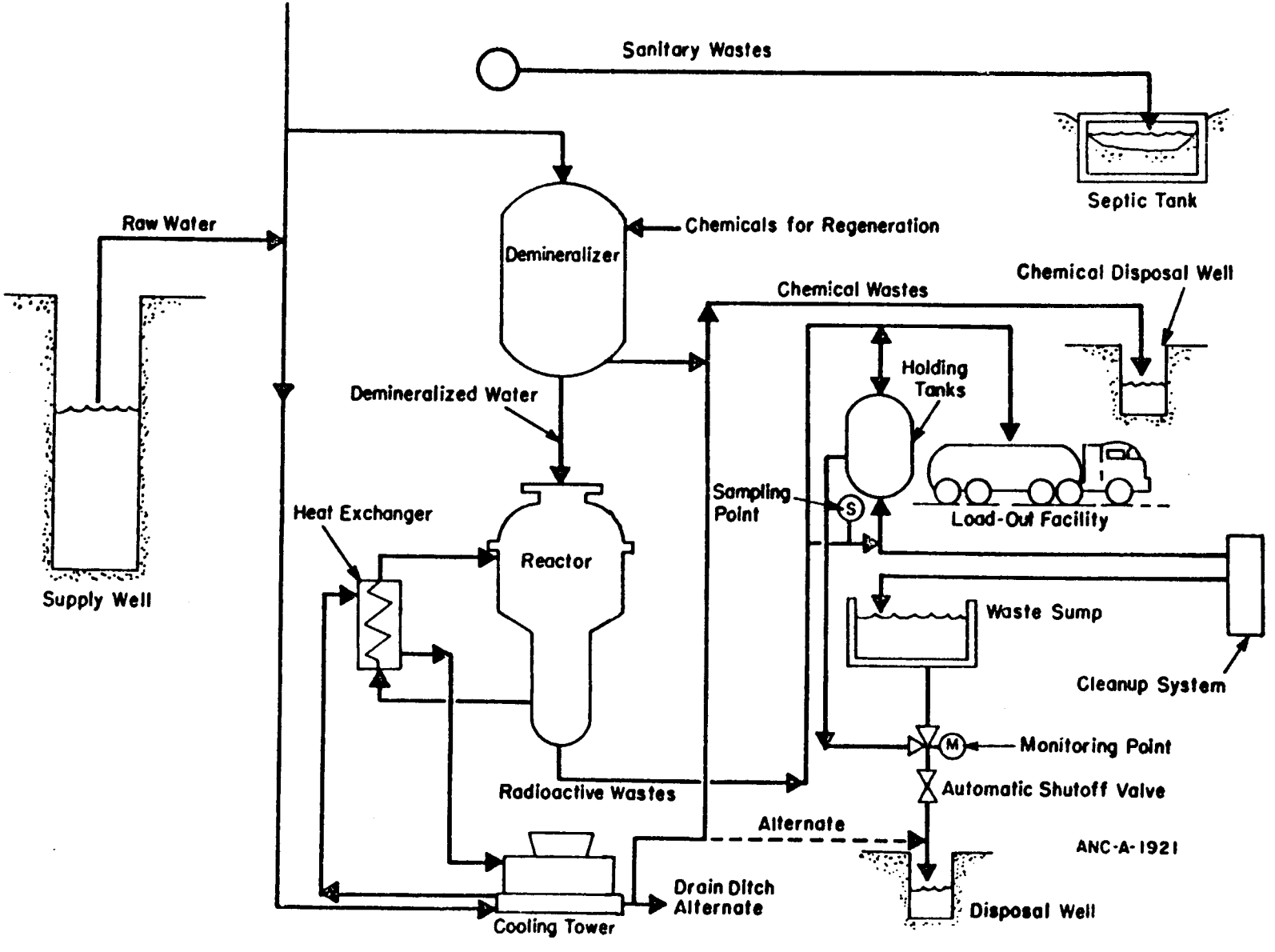

Figure II-36. Diagram of the PBF Systems for Disposal of Radioactive and Nonradioactive Liquid Wastes.

sump monitors for unexpected high release of radiation. If the setpoints on the monitor are exceeded, a signal from the detector interrupts power to the sump pump and initiates the closing of a valve leading to the disposal well, thus preventing the release of liquids with radioactive concentrations in excess of discharge standards specified in AECM (ERDA) Chapter 0524, Table II, column 2 (see Table II-43). Table II-43 only includes radionuclides with half-lives greater than 30 days. Radionuclides with half-lives less than 30 days are also well below

TABLE II-43

ANTICIPATED RADIONUCLIDE CONCENTRATIONS IN RADIOACTIVE LIQUID[a] WASTE DISCHARGED TO DISPOSAL WELL

Radionuclide	Radioactive Half-Life	Anticipated Concentrations During Normal Operations (μCi/ml)[b]	Concentration Guides for Drinking Water (μCi/ml)[c]
Strontium-89	50.8 days	4×10^{-7}	3×10^{-6}
Strontium-90	28.9 yr	4×10^{-8}	3×10^{-7}
Yttrium-91	58.8 days	$<3 \times 10^{-8}$	3×10^{-5}
Zirconium-95	65.5 days	$<2 \times 10^{-8}$	6×10^{-5}
Niobium-95	35.1 days	$<2 \times 10^{-8}$	1×10^{-4}
Ruthenium-103	39.8 days	3×10^{-8}	8×10^{-5}
Ruthenium-106	368 days	3×10^{-8}	1×10^{-5}
Tellurium-129m	34.1 days	$<1 \times 10^{-8}$	3×10^{-5}
Cesium-137	30.2 yr	4×10^{-8}	2×10^{-5}
Cerium-141	32.5 days	5×10^{-8}	9×10^{-5}
Cerium-144	284 days	5×10^{-8}	1×10^{-5}
Tritium	12.3 yr	3×10^{-5}	3×10^{-3}

[a] Only radionuclides with half-lives greater than 30 days are shown.

[b] The concentrations do not reflect the decontamination effect of the ion-exchange column, which is expected to reduce these concentrations considerably for most isotopes.

[c] AECM (ERDA) Chapter 0524, Table II, column 2.

discharge standards but are not included in the table. Initial experience with this system indicates approximately 50,000 gallons/yr of waste water will be released to the disposal well.

The major sources of radioactive liquid effluent (e.g., the experimental loop knockout drum, loop cubicle drains, and the stack drains) feed into a 1,000-gallon waste holding tank. This tank is adequate to contain all the liquids in the experimental loop. The contents of this tank are sampled by Health Physics personnel and then, depending on the measured concentrations, is either transported to the ICPP for processing or is routed to the disposal well.

The reactor and canal cleanup system includes a 14-ft^3 ion exchanger which can be valved to process either the reactor primary water or the canal water. The loop cleanup and decontamination system equipment consists of an interchanger, cooler, and two mixed-bed resin columns through which loop water can be circulated.

Intermediate-level radioactive liquid wastes resulting from PBF operations are transported to ICPP, then calcined to form a dry solid waste product. The calcined material is stored as described in Section II.A.3.

The low-level waste disposal well is a dry well located approximately 83 ft south of the reactor building. The well is approximately 110 ft deep and ends in naturally permeable rock strata (Figure II-37).

d. Systems for Disposal of Nonradioactive Liquid Wastes

Domestic waste from the PBF reactor building is processed in a 800-gallon septic tank. The effluent is discharged to a subsurface drainage field designed in accordance with U. S. Public Health Service specifications. The tank can accommodate an average flow of 30 gallons/day/person. This will provide a retention time of 8 to 16 hr for as many as 16 people, the normal number of occupants.

The domestic waste from the PBF control building is collected in an existing septic tank system which was previously used for the SPERT control building.

The principal nonradioactive liquid chemical wastes associated with the PBF operation are from regeneration of the demineralizer and from cooling tower blowdown. The cooling tower blowdown water contains impurities present in the raw water as well as sulfate ions from the acid used for pH adjustment. The water is treated with sulfur dioxide before discharge to reduce hexavalent chromium to trivalent chromium in order to prevent the release of hexavalent chromium ions that are used to inhibit corrosion. The demineralizer and cooling tower blowdown wastes are routed to the 116-ft deep disposal well. This is a dry well located approximately 135 ft southeast of the reactor building. Geologic features of this well are essentially the same as those given in Figure II-37. During 1974, 1,200 lb of sodium ions, 2,200 lb of sulfate ions,

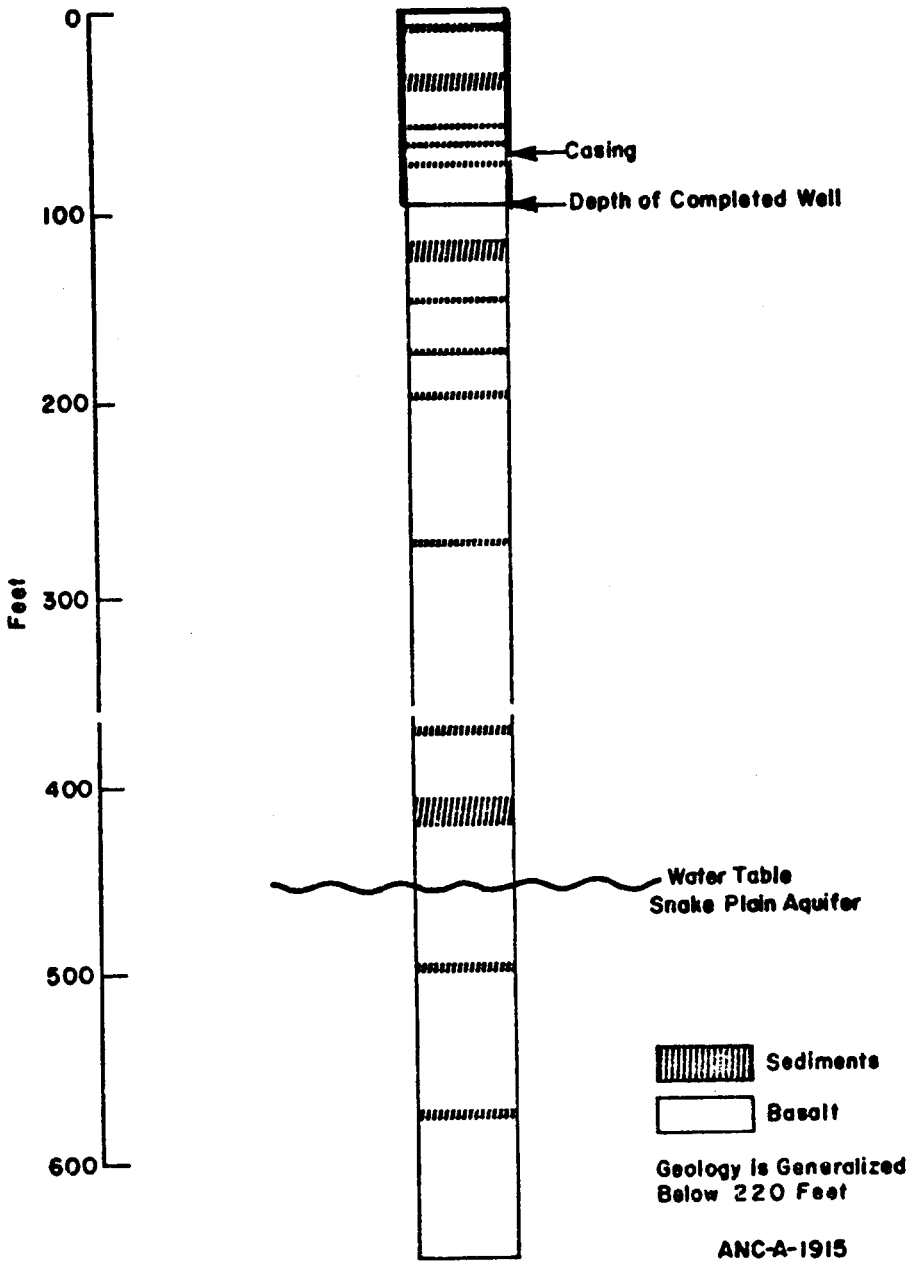

Figure II-37. Generalized Geologic Diagram of Shallow Waste Well.

350 lb of sulfur dioxide, and 820 lb of proprietary biocides were discharged in 314,000 gallons of water to the disposal well. The concentration of the sodium ion, sulfate ion, and sulfur dioxide was 459 ppm, 832 ppm and 132 ppm, respectively. As with the radioactive disposal well, the chemical disposal well provides an opportunity for removal of contaminants by ion exchange as the discharged water percolates through about 340 ft of basalt and sediments to the underground aquifer. The ion exchange occurring in the several soil layers greatly reduces the concentration of contaminants in the water before it reaches the aquifer.

e. Systems for Disposal of Radioactive and Nonradioactive Solid Wastes

Solid radioactive wastes from the PBF consist of contaminated filter material, used ion-exchange bed resins, and wastes from decontamination activities. Solid wastes are packaged to prevent spread of contamination, do not contain liquids, have a shielded container (when required) to reduce radiation hazard during transfer and disposal, and have adequate control during loading of material on transferring vehicles. The solid wastes are transported from the PBF area to the INEL Radioactive Waste Management Complex. Contaminated scrap material is either decontaminated and reused or is shipped to the Radioactive Waste Management Complex.

Nonradioactive wastes consist of solid office and construction debris. This waste is placed in suitable containers at the PBF and put into dumpsters for transfer to the CFA sanitary landfill.

7. Test Reactor Area (TRA)

a. Reactors and Facilities at the TRA

The TRA provides facilities for studying the performance of reactor materials and equipment components under high neutron flux conditions. While intended primarily for furthering the ERDA's reactor development programs, the facilities occasionally have been made available to educational, research, industrial, and commercial users, as well as other federal agencies.

The TRA is located in the south central part of the INEL as shown in Figure II-2. The TRA is divided functionally into two parts: a reactor area and a utility area. The reactor area contains the Materials Testing, Engineering Test, and Advanced Test reactors as well as three low-power reactors. These latter three reactors are the Engineering Test Reactor Critical (ETRC) facility, the Advanced Test Reactor Critical (ATRC) facility, and the Advanced Reactivity Measurement Facility (ARMF). Also located within the reactor area are the offices, warehouses, and maintenance facilities that support the reactor operations. The utility area contains nonnuclear support equipment and facilities. An aerial photograph of the TRA is shown in Figure II-38.

(1) Materials Testing Reactor (MTR)

The MTR building contains the reactor structure, extensive experimental facilities, and a storage canal. The main building contains the shielded reactor structure which is located in the center of the building. The top head of the reactor is removable to provide access to the reactor core for refueling and experiment handling. Most irradiated material is removed from the reactor tank through an underwater discharge mechanism to a storage canal.

Following the first nuclear startup on March 31, 1952, the reactor was operated at a power level of 30 MW(t) until September 1955 when the thermal output was increased to 40 MW. Demineralized water flows through the reactor tank in a closed-loop primary system to remove the 40 MW of heat which then is transferred to a secondary water system by a flash evaporator. The secondary water releases the heat to the atmosphere through a forced draft cooling tower.

The storage canal is filled with demineralized water under which spent fuel, irradiated samples, and radioactive equipment are stored. This reactor was placed on a standby status on April 23, 1970. Waste systems are still operable.

(2) Engineering Test Reactor (ETR)

The ETR became operational in 1957 with an operating power level of 175 MW(t). It provided more high-flux testing space, more stable flux, and a greater variety of flux levels than the MTR could provide, as well as "through the core" facilities.

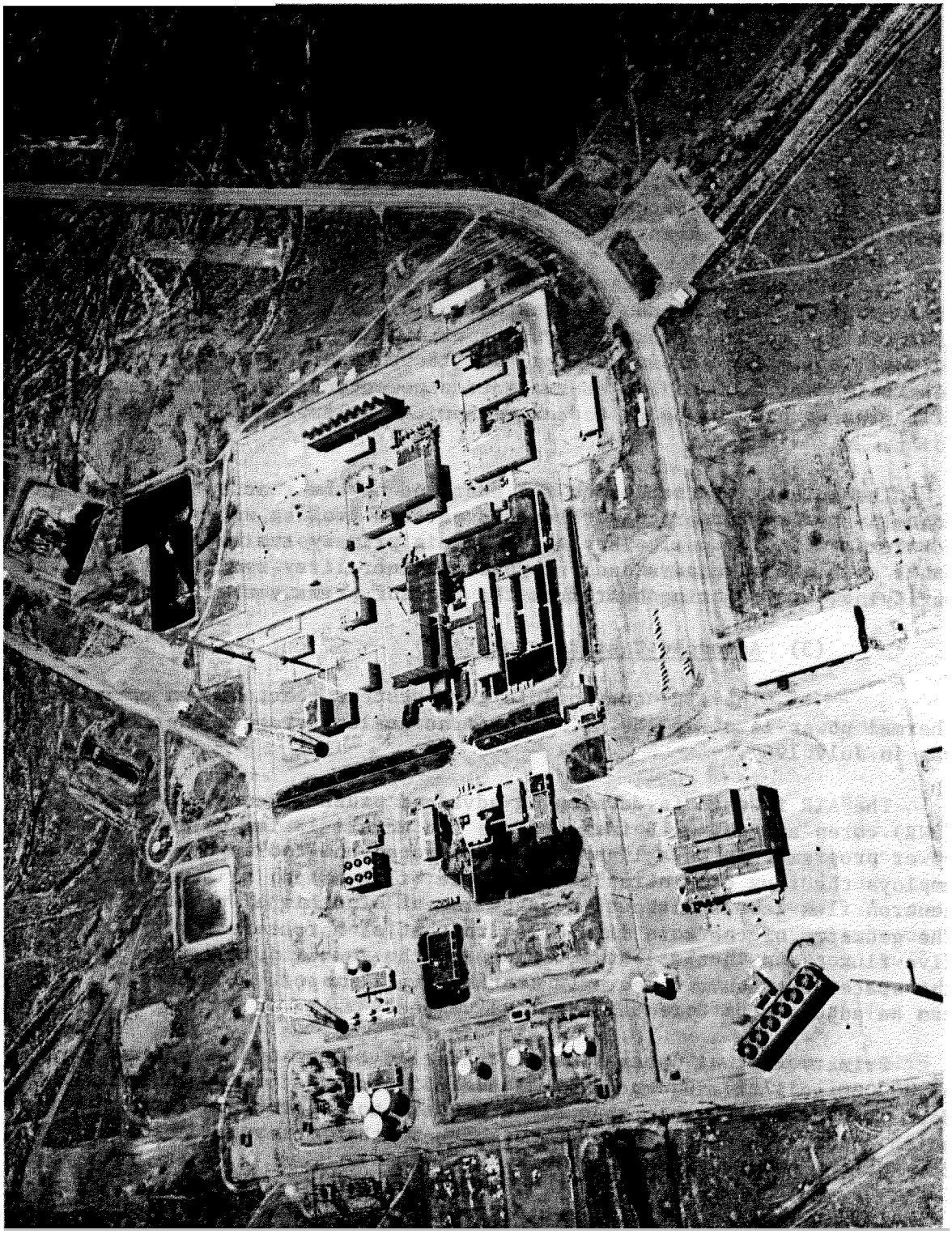

Figure II-38. Aerial View of the TRA.

It is housed in a three-story building with two complete floors below grade. The first basement houses experiment control panels; the second basement contains experimental equipment, housed in heavily shielded concrete cubicles.

The reactor main floor is relatively clear of plant and experimental equipment. A T-shaped storage canal is purged with 120 gallons/min of demineralized water circulating through the core. A closed-loop primary water system transfers the heat to a secondary cooling system by heat exchangers; the secondary system dissipates the heat to the atmosphere through a conventional forced draft cooling tower.

The major experimental facilities of the ETR consist of high-pressure water loops. These loops can pump as much as 100 gallons/min of high-pressure, high-temperature water past experimental fuel assemblies located in special facilities passing through the reactor core. These loops permit testing of fuel and other reactor components under a wide range of operating conditions up to and exceeding the experimental fuel failure point.

The buildings attached to the east end of the reactor building contain air compressors, heaters, and several cooling water systems for "experimental" use. They also contain primary system water pumps, banks of heat exchangers, and a bypass demineralizer system for circulating, purifying, and removing heat from the reactor primary water.

(3) Advanced Test Reactor (ATR)

The ATR, the world's largest test reactor, has an operating thermal power level of 250 MW. The first nuclear startup of the ATR was in July 1967.

The ATR is used in developing advanced pressurized water reactor (PWR) cores and advanced fuel systems and materials for space and commercial power programs. It is a light-water-moderated-and-cooled-system which employs the flux concentration principle (flux traps) to achieve higher neutron flux levels without the requirement of a higher power density. The geometry of the core is similar to that of a four-leaf clover with five flux traps in the leaves; one where the leaves join, and four in the spaces between the leaves. In the five flux spaces, flux levels can be adjusted to different initial values.

Primary coolant water flows in the closed-loop system at the rate of 48,000 gallons/min, under 130°F and 355-psi reactor inlet conditions. Heat is transferred through heat exchangers to a secondary cooling system which dissipates the heat to the atmosphere through evaporation in a 250-MW cooling tower.

The ATR is housed in a three-story building, of which two stories are below ground. The reactor main floor is relatively clear of plant and experiment equipment. The two basement levels contain experimental loop equipment. The experimental facilities at the ATR are all high-pressure water loops with characteristics similar to the ETR. A

low-power reactor (ATRC) occupies the west side of the main floor, and the east side of the main floor consists of offices. Just north of the ATR is a canal for the storage and handling of irradiated materials.

(4) Support Facilities

The support facilities include the ETRC, ATRC, ARMF, hot cells, metallurgy building, gamma facility, and MTR service building. A brief description of these facilities follows.

The ETRC and ATRC are full-scale low-power nuclear facsimiles of the ETR and ATR, respectively, and are used to verify nuclear calculations prior to operating the test reactors. The ARMF consists of two low-power reactors used for reactivity determinations.

A building north of the ETR houses three hot cells, all equipped with remotely operated machine tools, measuring instruments, and master-slave manipulators to permit metallurgical testing of samples irradiated in the test reactors.

The metallurgy building is a complete fuel fabrication facility and is used to prepare experimental fuel and other nuclear samples.

The gamma facility contains a canal and other facilities needed to use irradiated reactor fuel elements as gamma sources in various test programs. This facility is not in use at the present time.

The MTR service buildings provide space for experiment assembly, portions of the process water system, and laboratories and office space for technical personnel working at the MTR and the ETR.

(5) Utility Area

The utility area, lying in the northeastern portion of TRA, contains the utilities that serve the three principal reactors. These facilities include the water wells, raw water storage tanks and pumphouse, demineralizer, steamplant, fuel oil and diesel oil storage, MTR cooling tower, cooling tower pumphouse, transformers, and switchgear.

Two fuel oil and three diesel oil storage tanks are located along the north side of the utility area. Diesel oil is used for generation of backup electrical power; fuel oil is used in the steamplant. Steam for heating and process usages is supplied by three 17,500-lb/hr boilers which operate at 135 psi. Most of this steam is used for building heat.

(6) Waste Management Facilities

Various radioactive and nonradioactive airborne, liquid, and solid wastes are generated at TRA. Radioactive airborne wastes are discharged through stacks and special exhaust systems[45].

There are five liquid waste systems: sanitary, chemical, low-level radioactive, intermediate-level radioactive, and noncontaminated

water. The sanitary system involves a treatment plant with disposal to a pond. The chemical system accommodates solutions resulting from water softening and demineralization and discharges to another pond. The low-level radioactive system involves piping and sampling equipment with discharge to designated seepage ponds. The intermediate-level radioactive system includes piping, storage, and transfer equipment and no discharge. Noncontaminated water is discharged to a disposal well. Figure II-39 is a perspective drawing of the TRA showing the locations of some of the waste treatment systems.

b. Systems for Venting Radioactive Airborne Wastes[a]

Fans at the reactors bring air in large quantities from the outside into working areas. The air flows first through potentially slightly contaminated areas to high radiation areas, and is discharged to one of the three 250-ft-high stacks at the TRA. Negative pressures are maintained in contaminated and high radiation areas to minimize the spread of contamination. This air also collects gases from degassing tanks and other sources in the reactor primary and experimental systems. The effluents from all three stacks are monitored continuously. Both gaseous activity and particulate activity are measured and identified, and concentrations are calculated.

(1) ATR System

The ATR stack vents air from the main reactor operating floor and two basement areas. The system primarily is designed to circulate air from occupied areas to potentially radioactive areas and to the stack. Approximately 65,000 ft^3/min of air is circulated through the system. There are provisions for isolating these areas and stopping all airflow creating a gastight system even in case of a very large accidental release of radioactive material.

The stack is used also to discharge approximately 150 ft^3/min of air from the primary degassing tank, which is a main source of air activity in the effluent. Other activity sources are vents from the radioactive liquid holding tanks, the experiment cubicle vent header, and the reactor vessel cooling air system.

The exhaust from the stack is monitored for temperature, pressure, flow rate, as well as radioactivity. All this information is processed using a digital computer which calculates the mass flow and the radioactivity discharged to the atmosphere. The air volume and the quantity of principal radioactive isotopes released are reported monthly for incorporation into the INEL WMIS. The total release for 1974 amounted to approximately 27,000 Ci. Table II-44 gives the typical release composition and indicates that the predominant isotope is xenon-138. The particulate activity is about 2% of the radioactivity released from the ATR stack.

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[a] See Appendix E, Section 4.E. for planned system improvements.

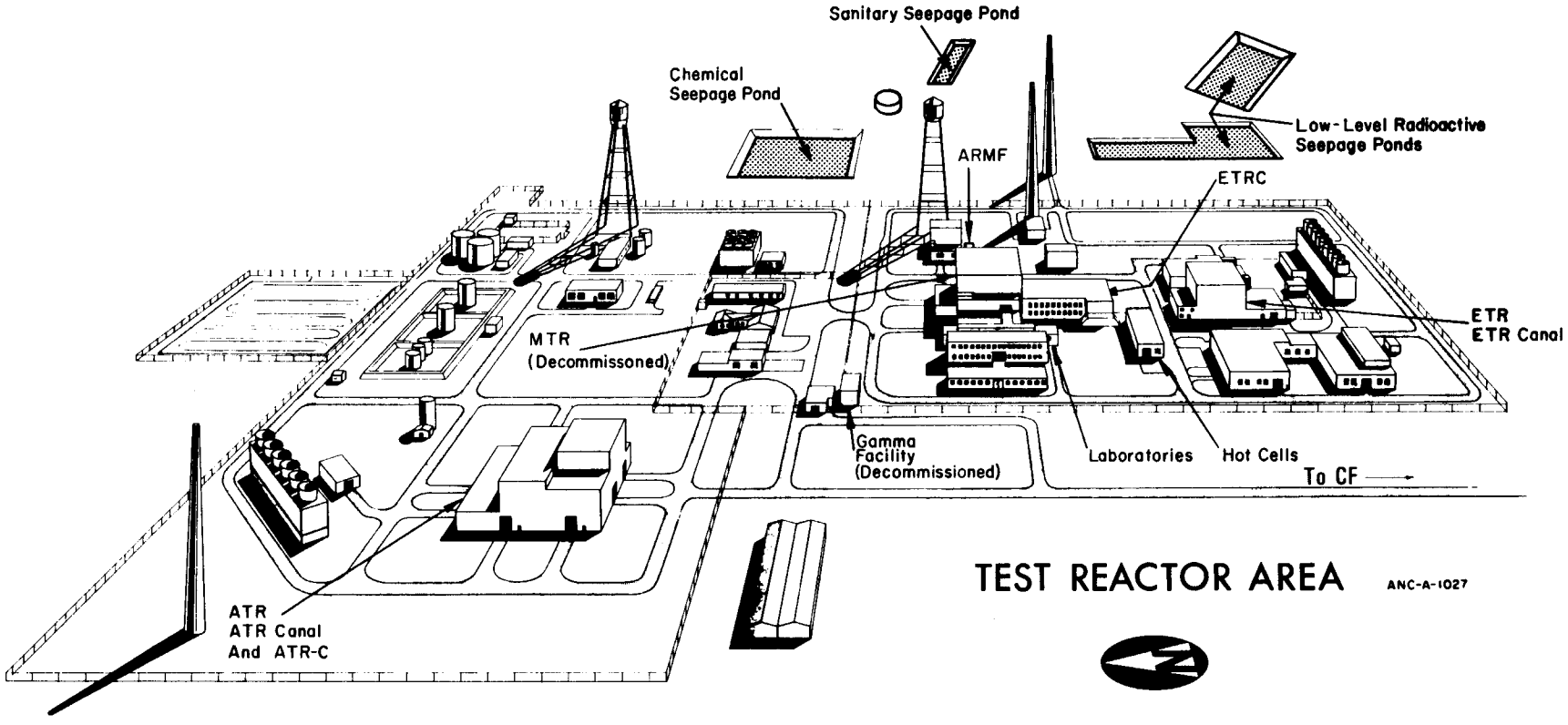

Figure II-39. Perspective View of the TRA.

TABLE II-44

TYPICAL ATR RADIOACTIVE AIRBORNE EFFLUENT COMPOSITION

Form	Isotope	Relative Percentage	Half-Life
Gaseous, 98%	Argon-41	15.2	1.8 hr
	Krypton-85m	4.8	4.4 hr
	Krypton-87	16.2	76 min
	Krypton-88	13.8	2.8 hr
	Krypton-89	2.0	3.2 min
	Xenon-133	2.1	5.3 day
	Xenon-135	15.0	9.2 hr
	Xenon-135m	6.4	16 min
	Xenon-138	24.5	14.2 min
Particulate, 2%	Barium-139	83.7	83 min
	Cesium-138	7.4	32.2 min
	Rubidium-88	7.5	17.7 min
	Rubidium-89	1.4	15.2 min

(2) ETR System

Ventilating air for the ETR system is discharged through the 250-ft-high ETR stack. The radioactivity in the airstream is measured by filtering the particulate of a sample stream. The gamma activity of the gaseous and particulate fractions is determined and recorded at the reactor control panel. If set values are exceeded, the recorder actuates alarms in the reactor control room, the process control panel, and the Health Physics room.

(3) MTR System

With the shutdown of the MTR, only these portions of the system serving the radioactive laboratories are of significance. Flow rate, pressure, temperature, and radiation instrumentation still are used to permit calculating activity releases through the system. Activity releases from the laboratories are controlled by caustic scrubbing of the exhausts from the laboratories which use acidic materials. Exhausts from laboratories not containing acidic vapors are filtered through HEPA filters to remove particulate matter and then are exhausted out the 250-ft-high MTR stack. Approximately 8 ft^3/min of the stack air is drawn from the stack into a monitor. The monitor readout is used to calculate the quantity of radionuclides released from the MTR stack.

Since the shutdown of the MTR, no detectable release of radioactivity from this stack has been observed.

(4) TRA Laboratory Exhaust

The laboratory hood exhaust system is used to maintain a slightly negative pressure on fume hoods and rooms in the laboratories not serviced by the MTR stack. Exhaust air from each laboratory passes through dampers, a HEPA filter, a blower, and the laboratory exhaust stack. The exhaust stack is located on the top west side of the MTR building. The system is equipped with instrumentation to indicate flow rate and the pressure differential across the absolute filters. Effluent exhaust from the laboratories and the total effluent exhaust are sampled continuously. Particulate activities are collected and analyzed routinely. The combined effluent exhaust sample is obtained downstream from the HEPA filters.

No detectable amounts of activity normally are released from the TRA laboratory exhaust stack.

(5) Summary of TRA Radioactive Airborne Releases

With the present sampling and monitoring systems, it is difficult to identify individual contributions to the total release. For instance, individual reactor degassing systems at the ETR and ATR have no provisions for sampling. The radioactive effluents ultimately released to the atmosphere from TRA are monitored by passing a gas sample through a continuous tape filter to determine gross gamma particulate and alpha particulate activities, a gamma detector for the total gaseous activity, and a charcoal filter for iodine determination. The detection limits of the monitor range from 6×10^{-8} µCi/ to 1×10^{-12} µCi/cc depending upon the radioisotopes being detected. The atmospheric releases for TRA are summarized by year and activity in Figure II-40. The individual nuclides encountered in 1974 are listed in Table II-45 with the activity and relative percentage of each noted.

Table II-46 shows the effect of decay on the identified radionuclides released in the TRA airborne effluent for the years 1962 through 1974. Detailed nuclide identification for years prior to 1962 is not available because of past recordkeeping procedures and detection limitations.

c. System for Venting Nonradioactive Airborne Wastes

The two major sources of nonradioactive chemically contaminated airborne effluents at the TRA are the steam generating facility and diesel engines.

The steamplant has three boilers each producing a total output capacity of 52,500 lb/hr of 135-psi saturated steam. During 1974, the steamplant burned approximately 1.1 million gallons of No. 5 fuel oil.

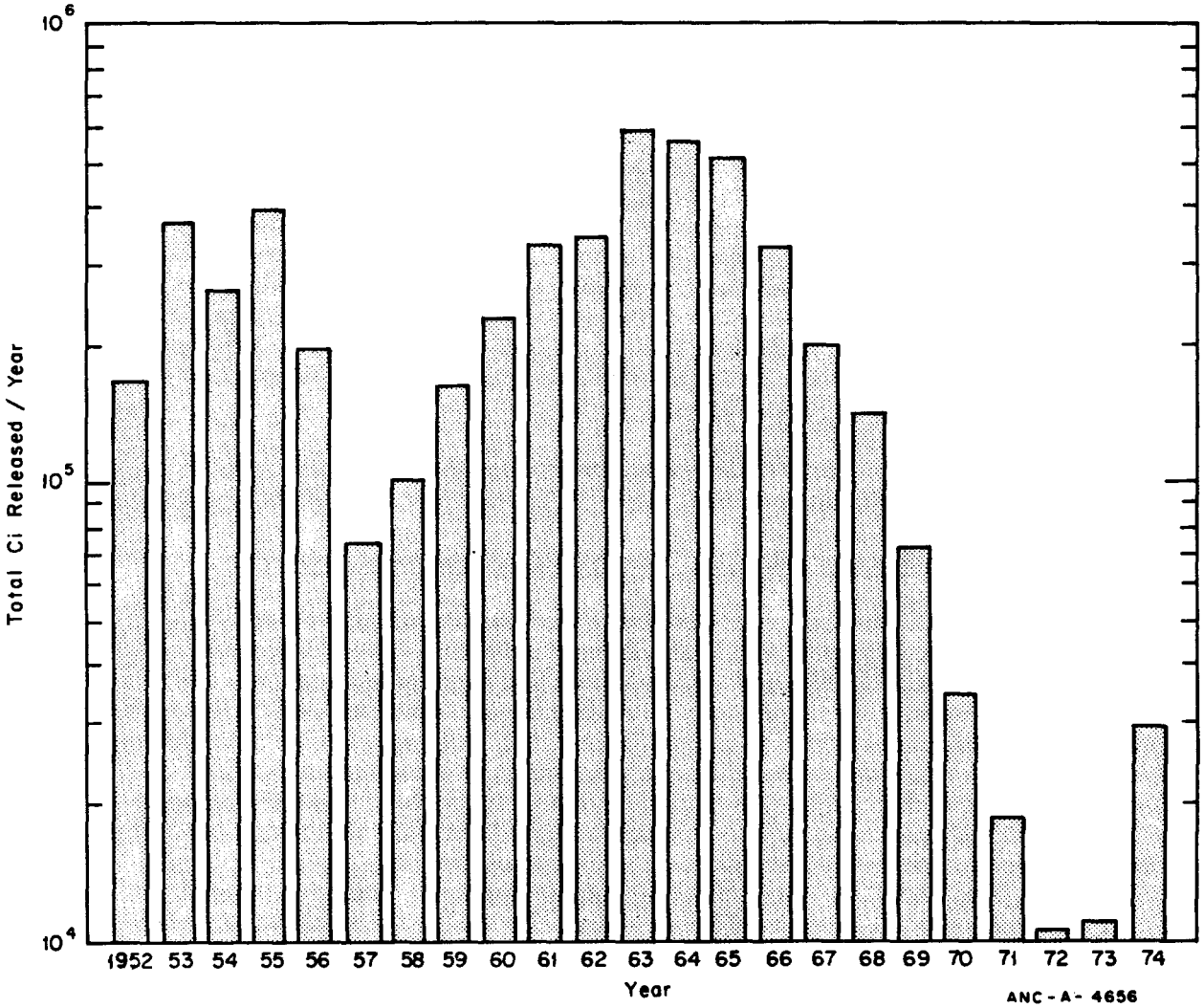

Figure II-40. Summary of TRA Atmospheric Releases.

Diesel engines are provided at the ATR, ETR, and MTR. The ATR has two diesel engines, one of which operates continuously during reactor operation. The ETR also has two diesel engines, one of which operates continuously during reactor operations. The MTR diesel has not operated since the MTR was put on standby status in 1970. These engines are exhausted directly to the atmosphere above the buildings. During 1974, the diesels burned approximately 400,000 gallons of diesel fuel.

The boiler stacks are sampled periodically to measure particulate and sulfur dioxide concentrations. During 1974, the oil-fired boilers and the diesel engines released approximately 300,000 lb of sulfur dioxide and 48,000 lb of particulate material to the atmosphere.

TABLE II-45

TRA AIRBORNE WASTE SUMMARY FOR 1974

Nuclide	Curies	Percentage of Total	Half-Life
Argon-41	3980	14.8	1.8 hr
Barium-139	509	1.9	83 min
Cesium-138	44	0.2	32.2 min
Krypton-85m	1273	4.7	4.4 hr
Krypton-87	4245	15.7	76 min
Krypton-88	3644	13.5	2.8 hr
Krypton-89	550	2.0	3.2 min
Rubidium-88	45	0.2	17.7 min
Rubidium-89	8	0.03	15.2 min
Xenon-133	571	2.1	5.3 day
Xenon-135	3952	14.7	9.2 hr
Xenon-135m	1708	6.3	16 min
Xenon-138	6432	23.8	14.2 min

d. System for Disposal of Radioactive Liquid Wastes[a]

There are three prime sources of radioactive waste water at the TRA. Water purged from canals with an activity concentration of about 4.5×10^{-5} mCi/ml contributes most of the waste volume. Purge from two main reactor primary water systems with an activity of approximately 4.5×10^{-1} μCi/ml contributes most of the radioactivity, especially sodium-24 which has a 15-hr half-life.

Radioactive liquid wastes at the TRA can be divided into two classes: (1) low-level, or those containing a small amount of radioactivity but not exceeding discharge limits; and (2) intermediate-level, or those too contaminated for immediate disposal to the lithosphere. The waste water contains corrosion products (such as chromium-51 and cobalt-60) and fission products (such as cesium-137 and strontium-90). The corrosion products contribute most of the long-lived curie content, but strontium-90 and cesium-137 have lower discharge limits.

Low-level wastes consist mainly of water from the primary system and experimental loops, and purge water from the canal and instrument systems. Most wastes are collected in catch tanks or sumps before they are pumped to a discharge system; reactor flush water and certain drains at the MTR are discharged directly to seepage ponds.

[a] See Appendix E, Section 4.E. for planned system improvements.

TABLE II-46

TRA RADIOACTIVE AIRBORNE EFFLUENT DECAY DATA

Released in Year	Curies	Decayed through 1/1/76 (Ci)	Decayed through 1/1/86 (Ci)
1962	349,100	<1	<1
1963	598,700	0	0
1964	569,300	0	0
1965	520,600	0	0
1966	334,200	2	1
1967	197,800	3	2
1968	126,200	2	1
1969	65,510	<1	<1
1970	34,810	<1	<1
1971	18,870	<1	<1
1972	10,380	<1	<1
1973	11,510	<1	<1
1974	26,960	<1	<1
Total	2,863,940	6	5

Intermediate-level wastes originate at the reactors, hot cells, the process water building, and the laboratories. These wastes consist of decontamination solutions or other wastes contaminated above discharge limits[7] such as could be generated if a fuel specimen in an experiment or a fuel element in the reactor experiences a fission break.

Since defective fuel specimens are sometimes tested in experimental loops, most loops are equipped with both a low- and intermediate-level waste system. Normally the low-level system is used, but the loop can be drained to the other system when necessary. The intermediate-level system discharges to the TRA holding tanks. When they are filled, the waste is shipped to ICPP for processing, or if decay has attenuated the activity to acceptable limits, the waste is discharged to a seepage pond. This waste also may be processed through the ETR bypass demineralizer.

The primary coolant systems, the secondary coolant systems, and the experimental loop systems have sampling apparatus. The gross activity of the water is monitored continuously, so activity is well known before the water is released to the waste disposal system.

In addition, discharged effluent water is monitored at the time of discharge.

Each main reactor and utility area has its own specific waste disposal system; however, all TRA systems use a common discharge point. A simplified flowsheet of these systems, both radioactive and nonradioactive, is shown in Figure II-41.

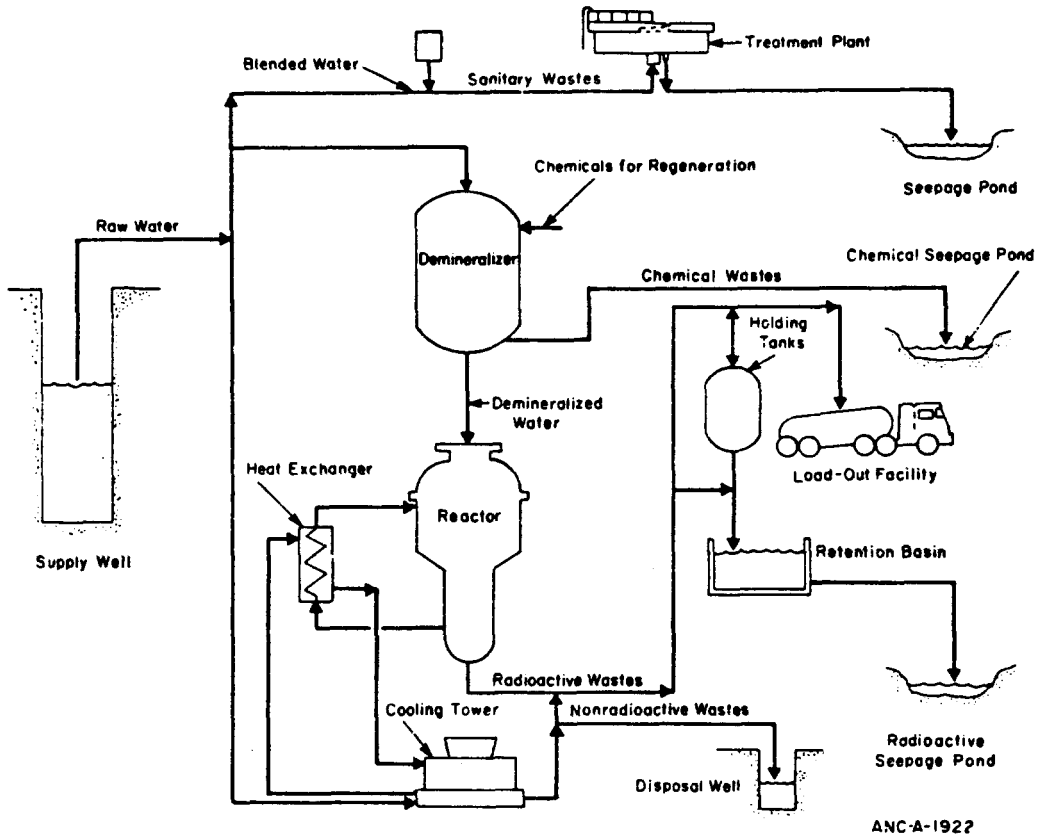

Figure II-41. TRA Liquid Waste Disposal System.

(1) ATR Holding Tanks

Figure II-42 is a schematic showing the holding tank systems for the TRA. The ATR system as two tanks; one has a 5,000-gallon capacity, and the other a 1,000-gallon capacity. Each has two pumps for transferring contents. Each is vented to the stack and provided with blowers to maintain a slight negative pressure. The 5,000-gallon tank serves the canal and cooling systems which are normally contaminated to a low level. A floor drain system also leads to this tank. A demineralizer system, consisting of two cation and two anion exchangers, also discharges to this tank. This holding tank system provides a means of maintaining a low level of activity in the reactor cooling water. Regeneration of these exchangers constitutes

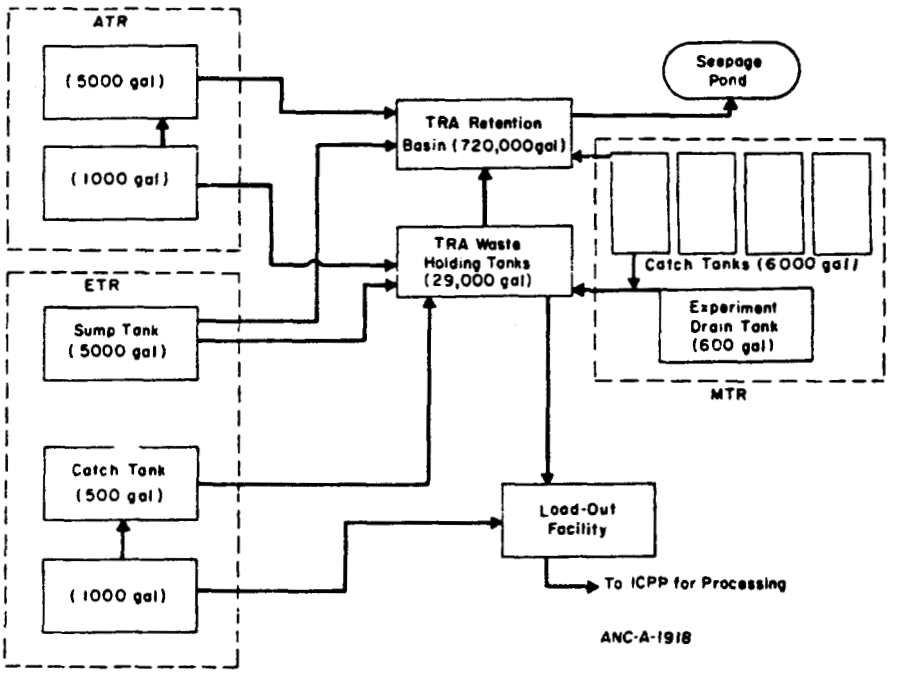

Figure II-42. TRA Radiological Liquid Waste System.

a major source of activity released to the seepage pond via the "retention basin." A canal cleaning system also occasionally discharges waste to these tanks.

The 1,000-gallon tank is designed to collect and contain those wastes with an activity that may exceed discharge limits. Analyses of batch samples taken from this tank provide a basis for routing the waste to the retention basin or to the large TRA holding tanks.

(2) ETR Holding Tanks

As shown in Figure II-42, three tanks are provided; one is a 5,000-gallon-capacity sump tank which collects waste water that normally can be channeled to discharge via the retention basin. Included in this category are canal drain water, cooling water, and other miscellaneous drains. Experimental water loops have bypass demineralizers which normally use nonregenerable resins to control quality; this water usually has low levels of contamination, but always is sampled before release to the tank system. Water from this tank can be pumped directly to the TRA holding tanks or to a 500-gallon catch tank which collects water from experimental loops that are known from sampling to be too contaminated for direct disposal. This 500-gallon tank usually is not sampled and is emptied to one of the TRA holding tanks. The third tank in this system has a 1,000-gallon capacity. It collects decontamination solutions containing special chemicals, suspended solids, and radioactive contaminants at a level too high for discharge. This tank can be emptied directly

to a loading facility and hauled to the ICPP or to the TRA holding tanks to undergo additional decay. Pumps are activated manually.

(3) MTR Tanks

Four 1,500-gallon black-iron glass lined catch tanks are located underground a short distance southwest of the MTR. Two of these tanks receive water from the MTR radioactive drain system in the reactor building. The other two receive water from the vent scrubber, the service building drains, contaminated sinks in laboratories, and the hot cells. While one of each of these pairs is receiving water, the other is either on standby or being sampled for radioactivity and drained.

The vent scrubber system collects radioactive and corrosive fumes from the various hoods in the laboratories and hot cells. The fumes are bubbled through caustic liquid to neutralize the acids and wash out most of the radioactivity. The caustic effluent is neutralized, then drained to the retention basin or the TRA holding tanks. The MTR experiment drain tank has a capacity of 600 gallons. This tank collects liquids from experiments which are known to contain decontamination solutions, corrosion products, and highly radioactive loop water. This water is pumped to one of the TRA waste holding tanks for temporary storage or disposal.

(4) TRA Waste Holding Tanks

The TRA waste holding facilities originally consisted of four tanks. These tanks are used to collect liquids that cannot be sent directly to the retention basins for disposal to the seepage ponds.

Two 9,000-gallon black-iron glass lined tanks were buried between the ETR and the retention basin. One of these tanks developed a leak and was removed in 1970 (described in Appendix C). Two 10,000-gallon stainless steel holding tanks are buried in the same area. These tanks are capable of receiving water from the ATR 1,000-gallon tank, both ETR tanks, any of the four MTR catch tanks, and the MTR experimental drain tank. The TRA waste holding tanks can discharge water to the retention basin, the tank truck loading facility, any other waste holding tank, and the ETR bypass demineralizer.

Waste is transferred from one of the waste holding tanks previously described after it has been sampled and determined to be too radioactive, too heavily contaminated with suspended solids, or too contaminated chemically for direct disposal through the retention basin. After a TRA waste holding tank is filled, usually once every four to six months, the contents are sampled. The effluent is pumped to the retention basin if the level of activity is below 1.1×10^{-2} μCi/ml beta-gamma; if the activity is above this value, the water is pumped to the tank truck loading facility. A 1,150-gallon shielded tank mounted on a truck is available for transferring the liquid to ICPP for evaporation or calcination.

During the past five years, the contents of the TRA waste holding tanks have been discharged to the retention basin after delays to permit radioactive decay.

(5) Retention Basin

East of the ETR facility are two underground rectangular concrete tanks separated by a 1-ft-thick concrete wall. These tanks were designed to receive radioactively contaminated water and to delay its passage for a sufficient time for short-lived radioactive contaminants to decay before being discharged to a seepage pond. The capacity of each is 360,000 gallons which is large enough to contain all the water from one reactor.

Waste leaving the basin is monitored continuously for total radioactivity. Baffles placed every 10 ft reduce back-mixing in the basin. Water from the retention basin is pumped to a radioactive seepage pond consisting of three sections where the water seeps into the ground.

Total flow to the retention basin is about 15 to 20 million gallon/month. Some of the low-level liquid[3] wastes are released intermittently (such as during reactor shutdown, when the reactor may be partially drained, when experimental loops may be purged and drained, etc.) Other wastes, such as the canal purges, are released at steady rates. Proportional samples of the waste discharging from the retention basin to the seepage pond are collected in a sample tank, this tank is sampled daily. The sample is analyzed for gamma emitting radioisotopes using a Germanium (Lithium) gamma-ray spectrometer and radiochemical analyses are performed to identify alpha and beta radioisotopes. The detection limit of this monitoring equipment ranges from 1.0 x 10^{-6} μCi/ml to 1.2 x 10^{-9} μCi/ml depending upon the isotope(s) being monitored[a].

During the past several years there has been a leak in the retention basin that has been releasing to the lithosphere about 10% of the received low-level waste prior to discharge to the seepage pond. A proposal to bypass the retention basin and route all low-level liquid wastes directly to the seepage pond along with the associated environmental assessment have been prepared and are now being considered.

(6) Seepage Ponds

The seepage ponds are used for disposal of water with low levels of radioactive contamination into the lithosphere. The natural absorptive and ion-exchange properties in the soil in the leaching pond are known to remove most of the radioactive impurities in the pond water. Tritium, which behaves as water itself, will percolate downward or evaporate from the surface of the ponds. A discussion on the impact of radionuclides discharged to the seepage ponds is presented in Section III.B.3.

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[a] See response to Comment X.11.2, Section X for additional information.

The seepage pond area is composed of three fenced pits. Two pits are 130 ft wide and 240 ft long, and one pit is 350 ft wide and 400 ft long. The liquid capacity of the three pits is approximately 19 million gallons. The seepage ponds are shown in Figure II-39.

(7) Tank Truck Loading Facility

A tank truck loading facility located east of the ETR building provides concrete-shielded piping for the transfer of radioactive liquid wastes from the TRA holding tanks and from the ETR 1,000-gallon decontamiation tank into a shielded tank truck for transport to the ICPP.

(8) TRA Liquid Release

Table II-47 lists the volume of liquid and the quantity of radioactivity released to the seepage pond for the years 1952 through 1974. Table II-48 provides a detailed breakdown of the nuclides released to the pond during 1974. The average concentration, total radioactivity (curies), and percent of total radioactivity for each nuclide are also presented. Table II-49 shows the effect of decay on the identified radionuclides released in the liquid effuent at TRA from 1962 through 1974.

e. Systems for Disposal of Nonradioactive Liquid Wastes

Water which is not radioactively contaminated is discharged either to a disposal well or to a chemical seepage pond.

(1) Well Disposal

Cooling tower blowdown furnishes the bulk of the nonradioactive or cold wastes, but water from air conditioning units, secondary system drains, and other nonradioactive drains at the reactors and supporting facilities is included in this category. A hydraulic test facility (which discharges about 300,000 gallons/month of nonradioactive waste), a metallurgy laboratory, hot cells, a steamplant, and the ETR compressor building are connected to this system. The wastes from these sources contain about 500 ppm of dissolved solids, primarily water "hardness" salts of calcium and magnesium. A corrosion inhibiting mixture used in the secondary cooling systems adds phosphate ions. Chlorine and sulfuric acid, added to the secondary system, are also present in small amounts. These wastes usually are discharged to the disposal well, although the wastes sometimes are diverted to the retention basin. Diversion to the retention basin generally occurs only when any detectable radioactive contamination is found in the wastes -- such as could occur if a leak in the reactor heat exchangers results in contamination of the secondary system water with primary reactor water. Should this occur, gamma monitors installed at the exit to each primary heat exchanger would detect the leakage and activate an alarm.

TABLE II-47

LIQUID WASTE DISCHARGED TO PONDS AT TRA (CURIES)

Year	Gallons x 10^6	Strontium-90	Cesium-137	Cobalt-60	Cerium-141/144[a]	Short-Lived[b]	Tritium	Total Activity
1952	5					63		63
1953	15					216		216
1954	95					1,141		1,141
1955	98					1,242		1,242
1956	94					839		839
1957	103					962		962
1958	249					3,073		3,073
1959	200					4,628		4,628
1960	221					3,439	[c]	3,439
1961	235	[d]	[d]	[d]	[d]	3,560	303	3,863[e]
1962	283	0.9	8	36	172	791	280	1,288
1963	202	1.1	6	14	98	786	353	1,258
1964	172	0.8	5	39	41	341	421	848
1965	146	1.5	6	14	22	244	328	616
1966	130	1.7	4	7	28	471	398	910
1967	181	27.0	5	33	39	496	424	1,024
1968	188	3.1	4	22	30	211	522	792
1969	266	8.1	11	21	27	2,446	749	3,262
1970	281	7.2	5	16	54	3,739	653	4,478
1971	219	14.6	10	4	27	2,008	342	2,406
1972	217	9.4	7	2	29	1,174	176	1,397
1973	264	4.3	4	4	6	1,316	184	1,518
1974	245	3.2	3	3	23	1,513	240	1,783
Total[f]	4,109	82.9	78	215	596	34,699	5,373	41,049

[a] Cerium-141 has a half-life of 32 days; cerium-144, 282 days.

[b] The nuclides include: sodium-24, 15 hr; strontium-89, 50 days; iodine-131, 8 days; chromium-51, 28 days; ruthenium/rhodium-106, 368 days and 30 sec; barium/lanthanum-140, 13 days and 40 hr; plus others.

[c] No analysis performed prior to 1961; activity estimated to be 330 Ci/yr.

[d] No analysis performed prior to 1962; included with short-lived.

[e] Gross activity prior to 1961 does not include tritium.

[f] Based on analysis of monthly composite samples.

TABLE II-48

LIQUID WASTE DISCHARGED TO PONDS AT TRA DURING 1974

Nuclide[a]	Half-Life	Curies	Percentage of Total
Barium/lanthanum-140	13 days/40 hr	1.86	0.104
Barium-140	13 days	18.1	1.0
Cerium-141	32.5 days	8.9	0.5
Cerium-144	284 days	14.5	0.8
Cesium-134	2 yr	1.0	0.06
Cesium-137	30.2 yr	3.4	0.2
Chromium-51	28 days	1344	75
Cobalt-58	71 days	0.1	0.01
Cobalt-60	5.2 yr	2.9	0.17
Iodine-129	1.7×10^7 yr	Trace	0.
Iodine-131	8.1 days	27	1.5
Lanthanum-140	40 hr	6.7	0.4
Niobium-95	35.1 days	2	0.1
Ruthenium-103	39 days	7	0.4
Sodium-24	15 hr	41	2.2
Strontium-89	50.8 days	12.3	0.7
Strontium-90	28.9 yr	3.2	0.2
Tritium	12.3 yr	240	13.4
Unidentified alpha	---	0.14	0.008

[a] Includes only those isotopes that are a major contributor to the total or are of radiological significance. Isotopes not listed include trace quantities of Ce-143, Fe-59, Hf-181, I-132, I-133, I-135, Lu-177, Nb-97, Sb-122, Ta-182, etc.

The secondary cooling water is purged via cooling tower blowdowns to maintain quality at acceptable levels. Prior to September 1972, the chloride concentration was maintained at 43 to 60 ppm. Chlorine concentration was maintained at 0.6 to 1.0 ppm by periodic addition of chlorine gas to the makeup water. The total hardness was maintained at 600 to 840 ppm, or 4 times the normal hardness of raw water. The pH of the water was and is maintained at 6.0 to 6.5 by addition of sulfuric acid. The hexavalent chromium concentration was maintained at 11 to 14 ppm by addition of a proprietary corrosion inhibitor, Betz-E-194. This inhibitor also contained zinc and phosphate based corrosion inhibitors.

The corrosion control treatment program was changed to an organic-silicate-phosphate inhibitor in September 1972 to eliminate hexavalent chromate release. Table II-50 shows a typical quality analysis following this change.

TABLE II-49

TRA RADIOACTIVE LIQUID EFFLUENT DECAY DATA

Released in Year	Curies	Decayed through 1/1/76		Decayed through 1/1/86	
		Curies	% Remaining	Curies	% Remaining
1962	1,288	270	21	207	16
1963	1,258	358	28	280	22
1964	848	369	44	267	31
1965	616	260	42	178	29
1966	910	379	42	276	30
1967	1,024	562	55	435	42
1968	792	448	57	294	37
1969	3,262	2,809	86	2,573	79
1970	4,474	3,957	88	3,742	84
1971	2,406	1,450	60	1,329	55
1972	1,397	191	14	123	9
1973	1,518	212	14	137	9
1974	1,786	259	14	156	9
Total	21,579	11,524	53	9,997	46

TABLE II-50

COLD WELL ANALYSIS

Dissolved solids	542 ppm
Total hardness	330 ppm
PO_4 (ion)	1.0 ppm
pH	7.95
Conductivity	370 μ mho/cm

The 1,271-ft-deep well into which the nonradioactive waste is discharged was drilled in 1963 near the retention basin. The casing ranges from 6 to 8 in. in diameter and is perforated at various intervals between 512 and 1,267 ft below the land surface. Disposal began in November 1964 and yearly discharges have ranged from 5 million gallons in 1964 to over 300 million gallons in 1974.

(2) Pond Disposal

The high purity water for reactor and experimental use is furnished by the TRA demineralizers. Regeneration of these units results in wastes containing a mixture of the regeneration chemicals (sodium hydroxide, sulfuric acid, and sodium chloride) and calcium and magnesium sulfates, bicarbonates, and chlorides. About 600 tons/yr of sulfuric acid and 282 tons/yr of sodium hydroxide are used for regeneration of the demineralizers. These regeneration wastes discharge to a chemical seepage pond (separate from the radioactive seepage ponds, see Figure II-39), where the water containing the dissolved solids can seep into the ground. The impact of these discharges to the environment is presented in Section III.B.4.

Average flow through the demineralizer plant is 450 gallons/min, a monthly average of 19.5 million gallons/month. Each month 100,000 lb of sulfuric acid and 47,000 lb of 50% sodium hydroxide are used to regenerate the cation and anion units. These chemicals, the hardness ions washed from the beds, and 3.2 million gallons of water per month are returned to the soil through the chemical waste seepage pond.

Two zeolite water softeners are available but are not presently being used. They can furnish soft water for portable water supplies at a maximum rate of 36 gallons/min/unit and are regenerated automatically by 112 lb of salt. During 1970, 8,000 lb of salt per month were used in the regeneration process, and the effluent was disposed of through the chemical seepage pond.

(3) Sanitary Wastes

The TRA sanitary waste system is separate from the other systems. Located east of the TRA as shown in Figure II-39, the system consists of a 3,400-gallon Imhoff tank, a trickling filter (0.0678-acre-ft), a final settling tank (2,480-gallons), and a chlorination tank. A 7,750-ft^2 seepage area is available, as are sludge drying beds. The system is designed to handle a flow of 59,000 gallons/day, and the actual flow is about 27,000 gallons/day. A BOD reduction in excess of 80% is attained. Effluent BOD ranges from 4.5 to 37 mg/l and is normally about 14 mg/l. No significant problems have occurred with this system. Figure II-43 is a diagrammatic sketch of the system. This system accommodates the buildings associated with the three reactor facilities. One building is served independently by a separate 600-gallon septic tank draining into a tiled drain field.

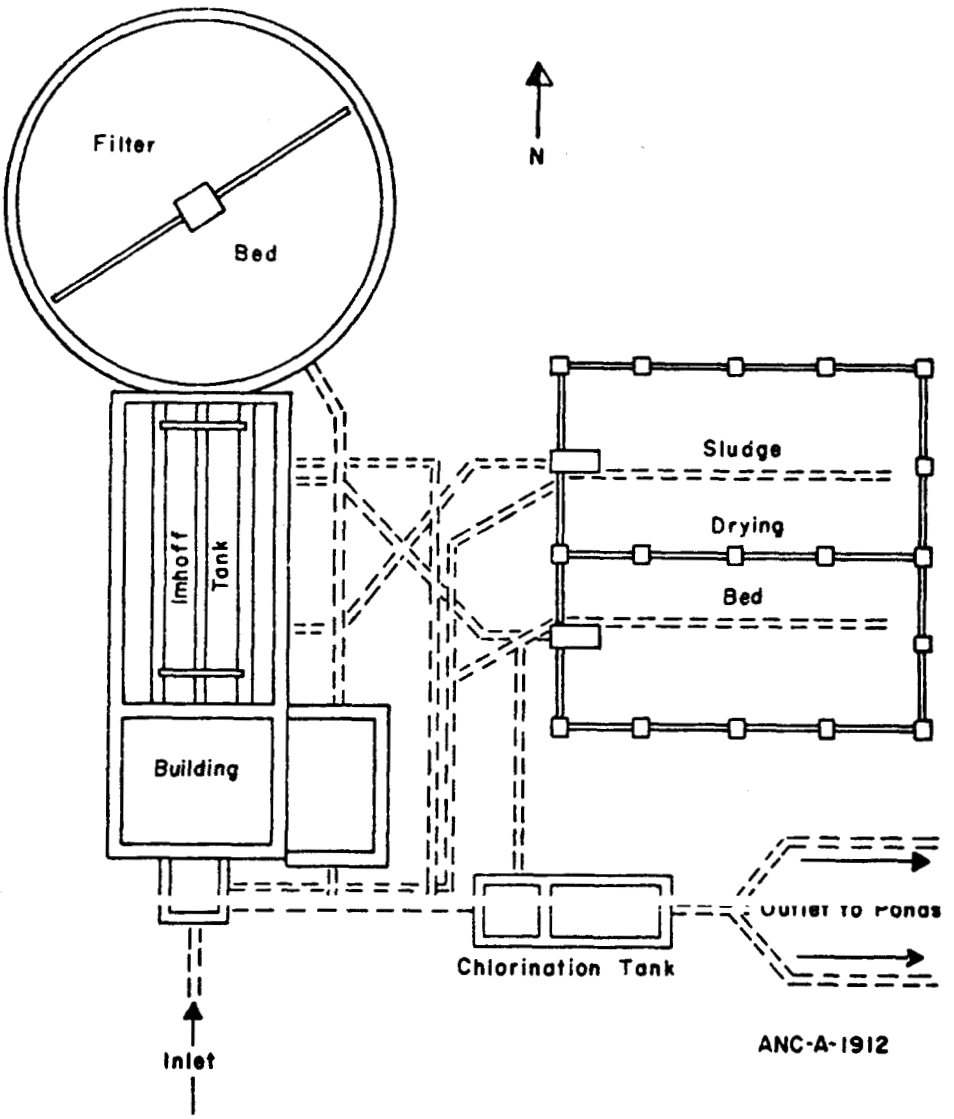

Figure II-43. Plan of the TRA Sewage Treatment Plant.

f. Systems for Disposal of Radioactive Solid Wastes

Various types of radioactive solid wastes are generated at the TRA. These wastes are all collected, monitored, and transported to the INEL Radioactive Waste Management Complex. Depending on the type, these wastes are packaged in approved cardboard cartons, carbon steel tanks, wooden boxes, metal cans, and heavy polyvinyl bags. The bags, which are contained in large metal covered boxes, are more suitable for the compactor recently installed at the INEL waste complex.

(1) Routine Trash Wastes

Every contaminated working area at the TRA is supplied with a metal solid waste receptacle containing a 12-ft^3-capacity

cardboard carton or a heavy plastic bag. Workmen must place all radioactive waste from the area into these containers, unless it is more practical to decontaminate and reuse an item. The material consists principally of blotting paper, rags, plastic items, and other such miscellaneous material. Metal and other bulky or heavy items are collected in more sturdy containers. As the containers are filled, they are monitored, secured with tape, and prepared for shipment by dumpster to the Radioactive Waste Management Complex.

(2) Spent Demineralizer Resin Wastes

Both the ETR and ATR use a bypass demineralizer system to maintain water purity and proper chemical conditions required for reactor coolant water. Each system has two cation resin tanks and two anion tanks. The reactor coolant contains very little dissolved solids. Consequently, the cation resins have a relatively long life; and a disposable type resin is used. The anion resin beds, however, are regenerated with a sodium hydroxide solution every three or four weeks. A resin bed that has degraded to the point it cannot maintain reactor water purity is flushed to a shielded container and drained. The spent resin then is shipped to the Radioactive Waste Management Complex.

All experimental water loops use nonregenerable resin in their bypass demineralizers. The demineralizers maintain the desired loop water chemical compositions during the test runs. The tests consist of irradiation of experimental fuel under very severe conditions, and many elements have deliberate cladding defects; so curie content of the loop resin is relatively high -- on the order of 500 Ci for the 1 ft^3 of resin. Both activated corrosion products and fission products are retained in the resins. These resins also are flushed from the loop into shielded containers for shipment to the Radioactive Waste Management Complex.

(3) Hot Cell Solid Wastes

Hot cell waste is transported in a shielded disposal carrier to the Radioactive Waste Management Complex. This waste consists of pieces of irradiated capsules and fuel elements and other highly radioactive items.

(4) Reactor Fuels Wastes

Reactor fuel is stored in the reactor canal for a limited time then shipped to the ICPP in shielded casks and stored to await processing. Experimental fuel usually is shipped to the sponsor in shielded casks. The end sections are cut from fuel elements before shipment, stored in the canal, then tranported for disposal to the Radioactive Waste Management Complex. These canal wastes, which are highly irradiated metal, do not represent a large volume of solid waste. Surplus irradiated "experiment" components and reactor components are handled similarly.

The wastes from TRA canals are transported in a specially designed shielded box mounted on a flatbed truck. Loading of the waste into the shielded container is accomplished underwater, and unloading and discharge at the Radioactive Waste Management Complex are accomplished remotely.

In 1974 TRA generated and transported to the INEL Radioactive Waste Management Complex 7,663 ft^3 of solid radioactive waste with a total of 742 Ci.

g. System of Disposal of Nonradioactive Solid Wastes

Routine nonradioactive solid wastes such as scrap paper, rags, wood, and metal are collected in specially marked containers, monitored to detect and eliminate any leakage of radioactivity, and transported by dumpster to the CFA sanitary landfill. In addition, food wastes from the TRA cafeteria also are transported to the landfill.

In 1974 the TRA generated and transported to the landfill approximately 5,000 yd^3 of nonradioactive wastes. Of this total approximately 170 yd^3 of waste were generated by the cafeteria, and most of the remainder consisted of rags, wood, paper, and other miscellaneous items.

h. System for Disposal of Thermal Waste

(1) Cooling Towers

The three cooling towers dissipate heat generated by the test reactors by evaporating nonradioactive water to the atmosphere. The ETR evaporates approximately 1,000 gallons/min at 175 MW, and the ATR evaporates approximately 1,880 gallons/min at 250 MW. The MTR is no longer in operation.

The evaporated water may be considered an atmospheric contaminant since some hardness ions and chemical additives used to maintain water chemistry are released to the atmosphere. In high winds, as much as 100 gallons/min of water with additives can be blown from a TRA cooling tower. The spray and additives are deposited on the ground downwind from the cooling tower. Loss of chemicals to the atmosphere in carryover and by evaporation has not been measured. The impact, however, is considered to be negligible.

(2) Space Heaters

An additional minor amount of heat is dissipated to the atmosphere as a result of the TRA heating systems.